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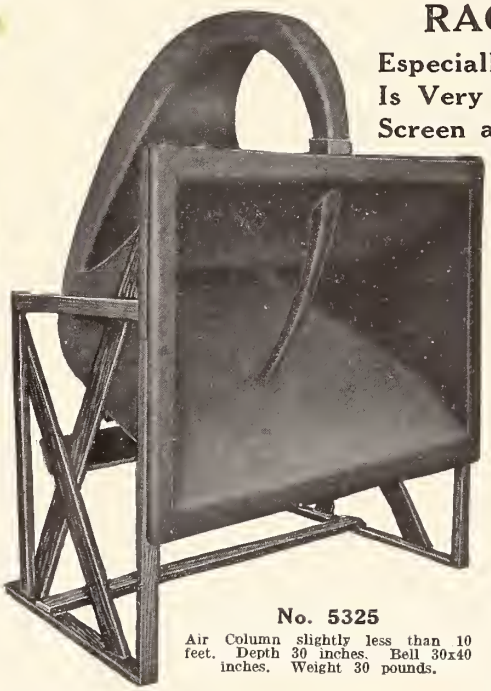

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Editorial

January, 1931

OPPORTUNITIES FOR PROJECTIONISTS

THROUGHOUT the United States and Canada there are thousands of young men who have before them opportunities for personal advancement, in but few cases sensed. We refer to sound-picture projectionists.

Within two or three years past a new art has come into use—the art of sound amplification. It requires some degree of imagination to visualize the possible practical applications of the new science. Of course, talking pictures are giving theatres added earning power and, as reproduction is improved all along the line, mechanized entertainment will gain new artistic placement in the amusement field.

In addition to the theatre field there are developing many commercial applications for the equipment and instruments now in the hands of theatre projectionists. Reference here is to audio amplifying equipment and to uses of the phototube.

Ordinarily a projectionist if he makes a success of his theatre work finds it necessary to devote time to the job in addition to that put in in the projection room. But, being first on the ground in thousands of communities, in knowledge of and experience with these new tools, the projectionist with a business head will overlook opportunity if he does not capitalize his advantage.

The limitations of the natural range of voice and other sounds have been removed. Audio amplifying systems are made by many dependable manufacturers. A hundred industries have uses for phototube operated systems, and a question here presented is: who will show these industries how they may use these new gifts of science to advantage and profit?

Nine of every ten fire alarm superintendents and about the same proportion of police signal superintendents in ten thousand communities were ex-telegraph employees. These men were on the ground and were familiar with the required instruments when the need arose. They capitalized their opportunities.

The daily mail reaching PROJECTION ENGINEERING discloses that demand is growing for information about these new developments and for men who have a working knowledge of the devices used.

A word to the wise . . . . . !

TELEVISION IN 1930

THERE are eight companies now engaged in designing equipment for television transmission and reception. A television parts merchandizing idea is to be launched soon on a large scale.

Occasionally there is published a story purporting to record that the large radio manufacturing companies are not interested in television. The following is from the annual review of the General Electric Company:

"Television was employed for the first time as part of a regular performance in a theatre, the television images being transmitted by radio from a studio located about one mile from the theatre.

"The active images of the performers were reproduced upon a screen 6 by 7½ feet, and were readily visible to those seated in the back rows of the balcony. The light impulses were transmitted on a wavelength of 140 meters, and were accompanied by voice and sound effects.

"This increase in area of the projected image from the previous maximum size of about 14 inches square to an area equivalent to about one-fourth that of the standard motion-picture screen was rendered possible by the introduction in the projection optical train of a light valve operating on the principle of altering the direction of polarization of a beam of polarized light by passing the beam through an electrostatic field. This light valve thus renders possible the use of more powerful rays of light than have heretofore been practicable in television projection.

"A television picture which had traveled approximately 20,000 miles through space was received with a fair degree of accuracy, thereby establishing a distance record for television reception. The picture, a rectangular design in black on a white card, was transmitted by the short-wave station, W2XAF (31.48 meters) at Schenectady, N. Y., received in Sydney, Australia, by station VK2ME, rebroadcast by that station (28.8 meters), and received back in Schenectady in about an eighth of a second."

Donald McNicol

Editor.

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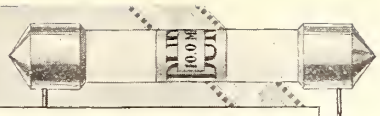

AMONG the many scientific contributions which have made talking pictures possible, none is more important than the use of amplifiers with our resistors.

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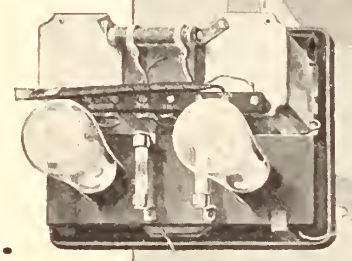

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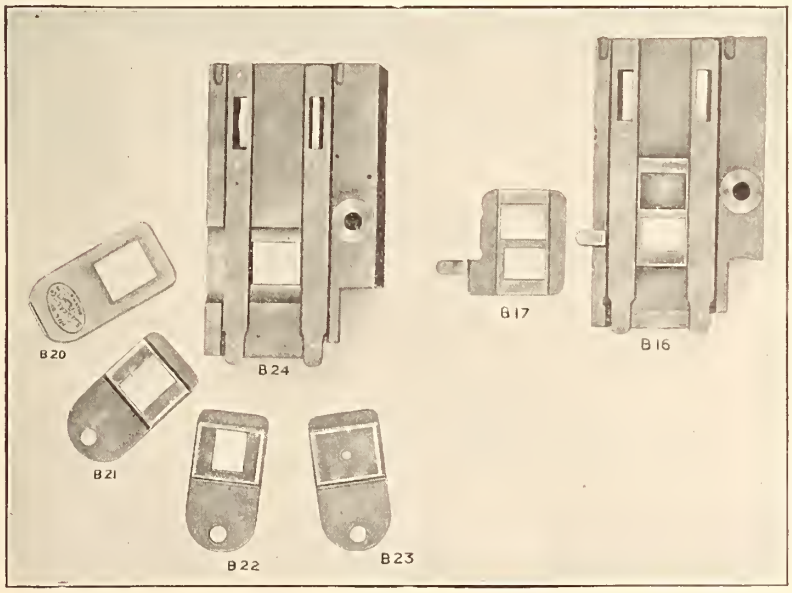

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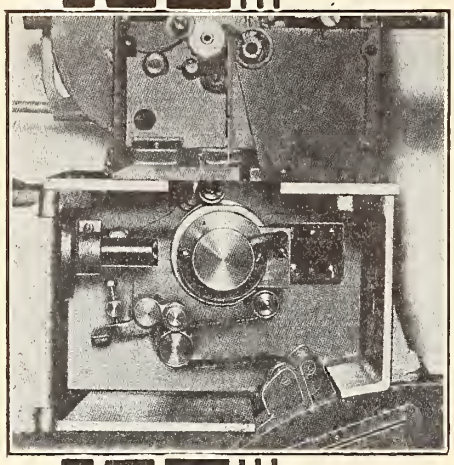

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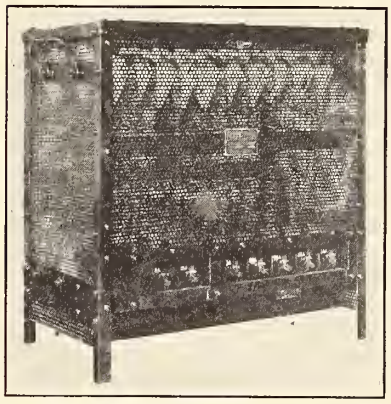

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JANUARY, 1931

Motion Pictures in Color

By Gordon S. Mitchell*

WHILE motion pictures in color have been a laboratory possibility since 1902, it was not until Warner Brothers released their production "On With the Show" that an all-color motion picture was a commercial possibility. This production served to arouse the public interest in color and was followed shortly after by the "Hollywood Revue" and several short subject releases. Since that time there have been many all-color productions photographed, some of which, of course, have been more successful than others. Within the last half year, the box office appeal of color has seemed to be on the wane—for which fact various reasons have been assigned. However, as the art of color cinematography advances and the pictures become more perfect, the public interest will again become manifest in color.

There are two possible methods of producing color motion pictures today; —the additive, in which certain colors are added to white in the process of photography and development of the film, and the subtractive, in which certain colors are subtracted from the colors left upon the film during these processes. Color filters are passed between the lens and film in such a way that only certain rays of light are allowed to register upon the film at any given instant. Both of the two main commercial processes operating in Hollywood at the present time are subtractive.

If we accept the wave theory of light transmission—that is, that light, like sound, is a wave motion—we can readily explain the separation of white light into its component colors. At the red end lie the long wavelengths and at the violet end the short. Intermediate lengths make up the color which lies in between these two extreme colors, such as yellow, orange, green and blue. Ordinary white light is composed of a combination of all wavelengths. If white light, such as sunlight, be passed through a crystal prism, it will be broken up into its component colors, due to the difference in the degree of bend experienced by the different wavelengths. Thus, the red end of the spectrum (as the light which is broken up into its fundamental colors is called) will be refracted, or bent the least, while the violet end will be bent the most. The light waves of different lengths, when they impinge upon the eye result in the various color sensations in the brain. The basic problem of color cinematography is to separate all of the light into its fundamental colors, procure a record of these colors upon the film, fix that record permanently, and at any desired time in the future project the picture which has been put onto the film upon a screen in such a manner that the record will again combine into the original colors.

An Informative Semi-Technical Account of the Various Processes of Producing Color Films

The Spectrum

While there are only seven pure colors in the spectrum of white light, there are over two hundred and thirty colors which may be encountered in color photography. However, these colors are all derived from the fundamental colors. If the spectrum be thought of as a circle, it is a fact that there are four principal points upon this circle occupied by the red, yellow, green and blue. Each of these four colors blends into the two adjacent colors, forming the intermediate colors which lie between the principal points, such as orange, blue, green, violet, etc. Any three of these colors, combining in certain given ways, may be made to produce any one of the more than two hundred and thirty color combinations of human experience. Why this is true has not yet been determined, yet it is a fact which has been scientifically proven. One of the most common combinations used in color work is that of red (or orange red), green and blue. These three colors, if combined in equal quantities will give white light, while if they be combined in unequal quantities will give some one of many colors. By a proper combination of these base colors, any desired color may be procured.

Color History of An Object

The photography of motion pictures in color at the present time depends upon the fact that if we first make a record of all of the red rays which are reflected by the object being photographed, then of all of the green, then of all of the blue, we will have a complete color history of that object. Then in order to reproduce our record, we must recombine these three separate records simultaneously upon the screen in the same proportions in which they existed in the object. The first color photography did just exactly this,—

*Sound Department, Universal Pictures Corpn.

three photos were taken in quick succession, each obtaining one color record. The red, the green and the blue were separately photographed by passing color filters in the correct succession before the lens. The film and filters were synchronized in such a way that every third frame passed before the lens at the time that the corresponding filter was in position. This required the photographing of three pictures where before in ordinary black and white photography it was only necessary to take one. The film and shutter had to move three times as fast as formerly. In projecting, an identical set of filters revolved before the lens, so synchronized that the red filter passed before the projector at the instant that the red picture was in place, the green filter before the green picture, and the blue filter before the blue picture.

Persistence of Vision

The photographing and projecting of motion pictures depends fundamentally upon the physiological law which is known as the Persistence of Vision principle. It will be recalled that this principle states that the eye will continue to retain any impression which actuates it for a period of time approximately equal to one eighth of a second after the impressing object has been removed. This phenomenon, which might be called the inertia principle of vision, applies to color impressions as well. If the eye be activated by a colored object, it will continue to see the color for the same period of time after the removal of the object—one eighth of a second. If another color be put into the field of vision before the expiration of this period of time, the second color will be superimposed upon the first, and both will register upon the brain. Were it not for this fact color pictures, as well as the ordinary black and white motion pictures, would be an impossibility. The audience will see the frame which contains the record of all of the red rays, continuing for one eighth of a second after removal, then all of the green, then all of the blue. The eye itself will blend these color records into a single unit of color which, if the photography has been faithful, will exactly correspond to the original.

Cause of Color Fringe Around Picture

For several reasons this type of cinematography has never been particularly successful. There was a pulsation of the picture, explained by some authorities as being due to eye fatigue. The eye was compelled to work hard and fast in order to register the many individual pictures upon the brain. Attempts were made at a later date to eliminate this fatigue by running still faster, thus making a slighter difference between pictures, but due to the extreme speed the wear upon the film was excessive. Flicker; that is, a pulsation due to the change of intensity of light upon the screen was another objectionable feature of this type of color projection. Fringing, a streaking of the various component colors especially noticeable after a rapid movement, was a factor which has not been, and in all probability never will be, entirely eliminated from this type of color photography. No matter how fast the individual color records were taken, in the case of rapid movement of the object, motion between the three separate color pictures would be shown. The three pictures would appear at slightly different positions upon the film. The red would not be exactly covered by the green, nor the green by the blue. This results in a fringe of the individual component colors showing around the edge of any rapidly moving object.

In Exports Sound Leads Silents

MOTION picture exports during the 1930 period increased over those of the corresponding period of 1929.

Europe leads in importing the largest proportion of sound pictures of American films sent abroad. The Far East ranks second, while Latin America, although using almost as many talking pictures as silent films, ranks last in utilization of sound films as compared to silent pictures exported by the United States.

American talking pictures are going to foreign countries in nearly double the quantity of silent films, according to preliminary figures for the first nine months of 1930, compiled by the Commerce Department's Motion Picture Division.

The total of all United States motion picture exports during the 1930 period was 210,037,969 linear feet as compared with 201,137,429 feet in the corresponding period of last year. Of this amount 137,448,391 feet were sound synchronized and 72,589,578 were silent, thus showing a percentage figure of 65.4 for the former and 34.6 for the latter.

Panchromatic Film

The film itself which carries this type of color record is black and white, the color value being latent in the film and appearing only when combined with the proper filter. The only difference appearing to the eye is in shading. A red automobile in the red frame would appear very light, in the green frame it would appear darker, while the green tree beside the road would appear very light in the green frame. The film used in this kind of work is known as "panchromatic film." Theoretically, panchromatic film and this type color photography have many advantages. The film may be developed in any laboratory without the use of special processes, while if the film itself is colored, additional dye processes are necessary,—which means extra time and expense. However, in spite of theoretical disadvantages, all of the operating commercial color methods in the motion picture industry today are of the type which uses a film containing the actual color values present upon the film.

There have been several methods of photographing motion pictures in color which for one reason or another have not been successful commercially, yet are of interest when considering the subject of color. A multiple film process which may at some time in the future develop into a commercial success has been the object of research, and works in this way. Instead of taking three pictures at minutely separated instants, this method proposes to take three individual pictures upon separate films at the same time. If three separate cameras are used, or three separate lens assemblies in the same camera, each lens with its appropriate filter, the picture would be taken with each from a slightly different angle, and so would not project correctly. However, if the same lens assembly be used, and the separate films be exposed to the correct color rays by means of prisms and filters, this fault will be eliminated. The same assembly in its entirety may be used in projecting—the three films each running behind its appropriate prism and filter. While the results achieved by this method are extremely beautiful, the synchronizing of the three films in order to place the correct picture of each color upon the screen exactly over the corresponding two pictures of the other colors is perhaps a commercial impossibility. It might be noted that this method gives the only absolutely true color representation. A short amount of film may be projected and kept in synchronism if under perfect laboratory conditions, but under the usual theatre conditions, this method is out of the question. The slightest lack of synchronism produces a blur. The shrinkage of one film a bit more than the other due to a slightly different temperature, or the smallest incorrect prism adjustment will be enough to completely spoil the effect.

Another method which resembles the foregoing in many details, yet which lacks many of the difficulties utilizes a set of prisms and reducing lens to take three tiny pictures upon one frame. These three pictures, each of one-fourth the usual height and regular width, lack much of the definition and detail of the larger picture. Each has its own color value latent in itself, and if the prism adjustment is correct for projection, will fit one upon the other

with no fringe. The same number of frames as in the ordinary black and white photography, and the same speed of projection are two obvious advantages claimed by the proponents of this method. However, complications present themselves which may or may not be worked out at some time in the future allowing this method to take its place with — or even replace — the commercial processes now in use.

These additive processes have been attempted at their best; that is, in using three colors. If only two colors are used nearly all of the two hundred and thirty colors may be recorded, and the complications are fewer. If the spectrum be roughly divided there will be a light and a dark region. The light region begins at the red and ends at the green, while the dark region begins at the green and ends at the violet beyond the blue. In the two color process of the additive method, one color which lies near the beginning of each region is selected. Bright red may be selected to represent the light region, while a green may represent the dark. However, certain natural colors may never be obtained by this method. If red and green be the base colors, yellow, blue or violet will not register as such. If blue be the base color of the dark region, green will not record upon the film as green. If orange be the base color for the light region, bright red will not photograph as red. While less complicated, limitations are imposed when the two color method is used. The speed, both of photography and projection is appreciably reduced by this method.

Multicolor and Technicolor

The two principal color methods in Hollywood which are operating commercially today, Multicolor and Technicolor, are both subtractive two-color processes. The Multicolor base colors are orange-red and blue. In contrast to the Technicolor method, Multicolor uses the standard motion picture camera without the addition of any filters or prisms. The company furnishes an attachment which is reasonably inexpensive, and a special magazine threaded with two films. These two films are placed emulsion to emulsion, so that the light shining through the lens strikes the celluloid side of the first film. The front film is so treated in the emulsion that it records only the dark end of the spectrum. A blue green picture of the object is impressed upon the first film. The emulsion of the front film is surface dyed red, so that in addition to recording the dark end of the spectrum it also acts as a color filter for the rear film. A red-orange color picture appears upon the back film. The two films are separated, developed, and a print made upon a film coated upon both sides. The record now consists of a film which contains a latent blue-green image upon one side, and a latent orange-red image upon the other. This film then goes through a chemical process in which the pictures upon one side of the film turn red, and those upon the other side turn blue-green. Contrasted with the dye process of Technicolor, this is a chemical conversion process. The actual chemicals which comprise the picture record are converted into other chemicals to make up the desired color photo. Many practical objections arose to this double coated film. It was claimed, and the claims upheld by practice that the film would scratch easily, break and crack, and quickly wear out. The Multicolor Corporation developed a special shellac with which the film was treated and which overcame the objections noted. With the Multicolor process it is impossible to obtain a bright red or yellow, but a very beautiful gold is obtained which closely approaches yellow. It might be noted in passing that if lighting conditions be perfect, it is possible to obtain a yellow, but under ordinary studio conditions, it is not practicable. The same difficulty is present in obtaining violet and purple. The green has a slight bluish tinge. Outdoor scenes when photographed in Multicolor are exceptionally beautiful. The blue of sea or sky seems to impress itself particularly well in this method, which is a distinct advantage and does much to recommend the method for outdoor work. One of the most beautiful motion picture shots which it has been my pleasure ever to witness was a Multicolor shot of a lake over which was thrown a gorgeous streak of golden moonlight. The combination of the dark of the lake and the gold of the moonlight was one which will always remain in memory as a vivid example of what is possible with color photography.

The Technicolor method uses a specially built camera, equipped with a special single lens and a set of prisms arranged so that the separate and individual color pictures are thrown upon successive frames of the same film. A revolving color filter is placed so that the one red and one green picture are photographed simultaneously. Thus, when the film is developed, there are two color sequences present upon the same film. Each set of color records is printed upon a separate positive—the red upon one and the green upon another. These prints are developed and fixed in the regular way. Each is then treated so that the silver images are concerted into mordanted images—that is, images which have the property of absorbing certain dyes. The positive having the red record is dyed green, while the print having the green record is dyed red. Then, a fresh film which is coated with a specially prepared gelatine is pressed successfully against the two prints. This gelatine absorbs the dye from the prints in the same manner that newsprint paper absorbs ink. The process of transfer of the image to the single gelatine coated film is called imbibition—referring to the property of the gelatine to imbibe the dye from the dyed film. Ordinary lithographing embraces the same process. The two color records, having now been transferred to the same side of one film, are ready for projection. A tremendous advantage of the Technicolor process is that no new attachments are necessary for the projection machine. The prints contain their own color and may be projected upon any ordinary machine.

There are certain outstanding disadvantages to this process. The dye tends to spread in the imbibition operation, much as ink spreads on the cheaper grades of newsprint paper, tending to make a hazy outline; each print will vary from another due to a slight difference in time it is allowed to remain in the bath, and there are certain natural colors which may never be obtained with this process. Red and green being the base colors of the Technicolor process, it is impossible to obtain a true blue, yellow or violet. Yellow will appear orange upon the screen. The final print contains the actual color upon the film and the combination of red and green will give a very close approximation to the natural color of the object. However, the two color process can never give as true a representation as the three, and the development of a commercially possible three color process is the aim of those connected with the color companies.

Summary

In conclusion, a brief comparison of these two methods, Multicolor and Technicolor, may be of interest. A great advantage of the chemical conversion method is that it is a process which goes to completion and stops. The amount of color does not vary from print to print, while in the dye process the amount of dye and the length of time the print remains in the dye bath determine the shadings and the amount of color which will be present in that individual print. Due to lack of imbibition, there is more definition to a chemical conversion print than there is to a dye process print. The dye process, however, has the advantage that it is able to register reds, which contributes much to scenes often encountered in motion picture photography.

Many studios, as well as companies formed for the express purpose, are at this time at work upon individual methods of color photography, and the future promises to bring out many interesting developments in this field of the motion picture industry.

Line Voltage Problems and Solutions

By J. W. Harmon*

In Sound Amplifying Systems Such Troubles as Short Life of Tubes, Tone Distortion and Blasting May Be Avoided by Employing Line Voltage Regulating Units

THE part played by line voltage in the operation of sound reproducing systems is not generally appreciated by the average engineer, installation man, or projectionist. Just because the term "110 volts" is universally and rather loosely used, it is taken for granted that line voltage must be definitely set at 110 volts at all times. This assumption is far from true. Readings taken in different sections of the country with recording voltmeters indicate a wide range of line voltages throughout the twenty-four hours of the average day. The fluctuations may be gradual during certain times of the day, due to definite load changes, or rapid and unexpected variations throughout the day, due to unexpected load conditions.

In the average sound installation, little or no attention is paid to line voltage fluctuations. At most, there are taps or switches to provide a choice of mean or average input voltages with given line voltages, but no provision is made for handling rapidly fluctuating line voltages which constitute the real problem. In other words, it is not so much a question as to whether the line voltage averages 105 or 125 volts, as it is a matter of following the rapid changes in line voltage from 105 to 135 volts throughout the entire day.

In the sound system installation, good tone quality and uniformly sustained volume are a far greater importance than in the home radio set. The listeners expect and demand maximum realism with minimum nervous strain. Because of the extreme volume required to fill a theatre, auditorium, church, or hall, differences in volume and tone are readily detected by critical listeners. Therefore, it is essential to maintain both factors of a uniform level.

Compensating for Voltage Variations

Fortunately, while nothing can be done about fluctuating line voltage in a preventive way, much can be done by way of compensating for line voltage fluctuations. It is possible to employ self-adjusting line voltage controls which maintain a given input voltage by automatically changing in resistance as the line fluctuates up and down. Such units must not only protect equipment and tubes against excessive voltage by introducing the proper amount of voltage drop, but must also reduce the voltage drop as the line voltage decreases, so as to strike the desired uniform input voltage at all times.

It is generally assumed that the general problem of fluctuating line voltage is one of abnormal line voltage, resulting in excessive wear and tear on tubes and on power packs. While excessive voltages generally work the greatest havoc, it is nevertheless true that subnormal line voltages are almost equally troublesome. Not only are tone quality and volume greatly hampered by subnormal voltages, but power tubes and rectifiers break down when filament supply voltages are reduced below safe limits. Such tubes either have a tendency to arc when operating on insufficient filament voltage, or the filaments crystallize and become brittle, in either event calling for premature replacement.

The ideal method of compensating for fluctuating line voltages is the use of a reduced voltage primary for the power transformer, together with a self-adjusting balancing resistance in the primary or supply circuit. In the case of the usual 110-volt supply, the primary is wound for 90 volts, while the self-adjusting line voltage control inserted in one leg of the primary circuit serves to reduce the line voltage to the 90-volt input. In such an arrangement it is possible to regulate line voltages anywhere from 95 to 135 volts, maintaining the primary voltage within the 5 per cent plus or minus specified by tube manufacturers. Already, many radio set manufacturers have realized the necessity for line voltage compensation, and have built this feature into their radio assemblies. This practice is bound to become commonplace in radio broadcast reception, and is of even greater importance in sound reproducing systems.

In the absence of low primary feature, however, it is still possible to introduce line voltage compensating means in the sound reproducing system. This may be done externally, and without any changes in the equipment itself. It is simply a matter of placing one or more mounting sockets in series with the primary or supply circuits, inserting the necessary type and number of control devices, so as to introduce the current carrying capacity corresponding to the requirements of the apparatus used. The control unit, through its automatically variable resistance, supplies the necessary voltage drop so as to maintain a uniform input voltage at all times, despite wide line-voltage fluctuations between 100 and 140 volts.

The Symptoms

There are several symptoms that positively indicate line voltage fluctuations exceeding the safe limits. When tubes burn out prematurely, for instance, it is usually an indication of excessive line voltage, Tube life may be reduced 50 per cent or more when line voltage fluctuates above the rated tube requirements. Tone distortion and blasting are also caused by excessive line voltage. Power-pack breakdowns are by no means rare when operating on excessive line voltages. Tube noises are usually an indication of excessive line voltage.

Subnormal line voltages, while perhaps not as costly as abnormal line

*Amperite Corporation

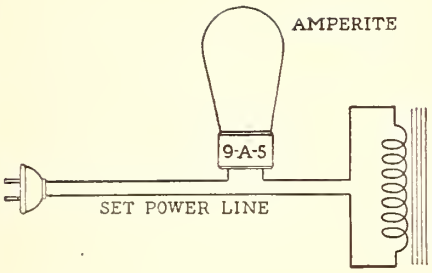
voltages, are even more troublesome. Diminished volume, even with the volume control turned on full, is usually an indication of subnormal line voltage. Poor tone quality is also a symptom of low line voltage. Finally, tube failure may frequently be due to subnormal line voltage, since filaments crystallize when insufficient voltage is applied on the filaments. Also, certain types of power tubes have a tendency to arc when operating at insufficient filament temperature.

With proper line voltage compensation, it is possible to maintain the input voltage with 5 per cent plus or minus the ideal operating voltage, despite fluctuations of 15 per cent plus or minus the mean line voltage.

There are various forms of line voltage control, some of them fully automatic, while others are either fixed or, at best, manually operated. The fixed resistance units serve to reduce the line voltage only, provided the line voltage stays reasonably constant at a high value. In other words, where line voltage runs uniformly high, it is possible to insert a fixed resistance in the ordinary circuit, reducing the applied voltage to a safe value. However, such a fixed resistor does not take care of conditions when the line voltage drops to a lower value. The resistance remains in circuit, consequently dropping the applied voltage below the desired value, and bringing about the unsatisfactory conditions due to subnormal voltage. Such devices are frequently made in tapped form, so as to provide a suitable range of voltage drop, to take care of varying conditions, if one knows what tap to use—and when.

For automatic or self-adjusting line voltage controls, is the type illustrated herewith which can be relied upon to control line voltage fluctuations even though they may extend up to 140 volts, which is by no means uncommon.

The Amperite type of voltage control is in the form of a glass bulb, not unlike the usual radio tube, containing a special wire winding in an atmosphere of nitrogen. The bulb is frosted to distinguish it from radio tubes and provided with a two-prong base, for use



in either the standard UX socket or a special mounting socket.

The unit is available in a wide range of current capacities. Also, it is possible to employ two or more bulbs in series parallel, so as to handle any given load in the form of the sound reproducing equipment.

Not only does line voltage control insure a longer life for the costly radio tubes employed in the usual sound reproducing system, as well as protection for the equipment itself, but more uniform results are an absolute certainty as the result of properly controlled input voltage.

ACADEMY OF MOTION PICTURE ARTS AND SCIENCES

President William C. de Mille, of the Academy of Motion Picture Arts and Sciences, after consultation with other officers, branch executive committees and members, has appointed as members of the Producers-Technicians Committee, administering the Academy technical bureau: Irving Thalberg, chairman; M. C. Levee, Fred W. Beetson, Sol Wurtzel, Charles Sullivan, Henry Henigson, H. Keith Weeks, J. A. Ball, Fred Pelton, J. T. Reed, Carl Dreher, Nugent H. Slaughter, Frederick M. Sammis, and K. F. Morgan.

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METROPOLITAN MAKING A FILM FOR AMERICAN TELEPHONE AND TELEGRAPH COMPANY

THE industrial division of Metropolitan Sound Studios at Hollywood, California, reports that it has been awarded the production of an industrial picture for the American Telephone and Telegraph Company, entitled "Making the Grade." The production will be in a measure a dramatic one, and will visualize the hazards attending the duties of linemen. It will be shown within the organization, as well as to the public, and will display the esprit de corps of this group of technical men, who know no danger when telephone property is in jeopardy. Charley Grapewin plays a featured role in this production, and will be supported by Eddie Baker, F. D. Wilcox, Bob Chapman, Charles Hamilton, and several employees of the American Telephone and Telegraph Company will also appear in the production. The picture is to be directed by Charles H. Brownell of Metropolitan's industrial department, and Jerry M. Hamilton, of New York City, representing the Telephone Company.

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17,500,000 LUMENS OF LIGHT -- AND ARRESTED MOTION

A FLASHLIGHT battery is powerful enough to release a flash of 17,500,000 lumens of light—or even more—in a reflector designed by the General Electric Company for use of photographers at its Schenectady plant. The reflector, which employs the new Photoflash lamp recently announced by the company, contains seven standard sockets placed at various angles within a dull aluminum reflector. The sockets are so arranged that the bulbs themselves are uniformly spaced within the reflector to supply an intense, momentary light for the making of photographs of larger interiors in spite of adverse natural light conditions. The reflector is attached to an ordinary flashlight cell container, and the bulbs are wired in parallel so that all are flashed simultaneously.

Investigations at the engineering laboratory of the incandescent lamp department of the company at Cleveland show that the new lamp, which replaces flashlight powder and makes possible pictures hitherto impossible because of fire or accident hazard, has an output of 200,000 candlepower, or about 2,500,000 lumens, as a bare lamp. The use of a reflector will increase this three or four fold within a limited angle, so that a single lamp in a reflector has an output of upwards to 600,000 candlepower.

Further investigations at the laboratory show that the flash of the lamp rises very rapidly in intensity, drops quickly, and then trails off for a longer period. The intensity of the flash which is photographically effective lasts for about 1/50th of a second. This is further shown by actual exposures, in which it is proved that the flash is sufficiently fast to stop action that can ordinarily be stopped by a camera in such a time.

The Photoflash lamp consists of a clear bulb of standard design, with the flashlight filament coated with a special preparation, and with a quantity of very thin aluminum foil in crumpled sheet form within the oxygen-filled bulb. When the circuit is closed the filament is lighted and this, in turn, lights the foil, giving a flash of intense light. The lamp operates on any 115-volt house supply, or with dry, storage or flashlight batteries. A new lamp is needed for each flash.

Monitoring Sound Motion Pictures

PART III

By CHARLES FELSTEAD *

Shooting a scene with portable sound equipment. Cameras in sound-proof blimps in center; portable microphone boom at right. Picture: "Fingerprints."

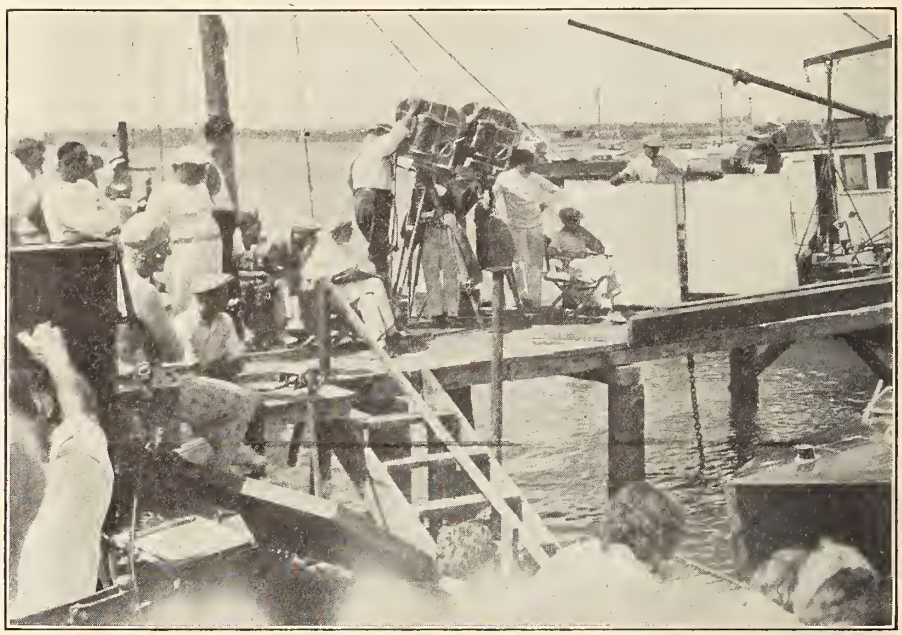

Figure 1.

WE will take up the practical side of monitoring work in this article. It will be necessary first that we discuss the construction of sets having the necessary acoustic properties for the recording of sound before discussing the types of microphones used and the manner in which they are arranged for recording.

When sound was first introduced into motion picture work, it was found that the sets used for the shooting of silent pictures were entirely unsuited for use in the talkies. Accordingly, engineers had to cast about and discover new ways to construct sets with the proper acoustic properties and which would photograph satisfactorily. In the beginning, many experiments were tried in set construction in endeavoring to fulfill these two requirements. It was necessary that the set have just the right amount of reverberation, neither too little nor too much; because too little reverberation would cause a set to sound "dead", while too much reverberation would produce a set that was too "live." As practically all of these early sets were built inside of the sound stages, there was little occasion to worry about reverberation from surfaces outside of the set proper, because the walls of the sound stage were covered with sound-absorbing materials and so heavily draped that the effect of any reverberation coming from them could be discarded. It will be interesting to review here some of these experiments and the results obtained from them.

* *Sound Engineer, Universal Pictures Corporation.*

Early Sound Sets

The first sound sets tried out were constructed of heavy cloth, such as canvas, covered with paint to make it stiff resembling a solid wall. A heavy framework was used to hold the cloth in much the same manner as the canvas of an oil painting is supported. A very realistic appearing set could be constructed quite cheaply in this manner. These cloth sets were not satisfactory, however, because they offered almost no opposition to the passage of sounds of a high-frequency, and so practically no reverberation was obtained from them; but low-frequency sounds were reflected by these walls to such an extent that the set sounded very "boomy" or "tubby." The effect was more or less like shouting into an open barrel.

The designers went to the other extreme in the next sets and constructed them of Celotex, Flax-li-num, and other sound-absorbing materials. This resulted in a set that was also very boomy; but in this case, the high frequencies were absorbed by the material in the set walls, instead of passing through them as in the cloth sets. Both of these types of sets lacked sufficient reverberation of the "highs" to sound natural when recording was done in them. Hard materials that would produce the proper balance of reverberation of all frequencies were almost entirely absent in these sets.

It was found that sound-absorbing material absorbs high-frequency sounds to a much greater extent than it does sounds of low-frequency. Hard materials, such as wood and metal, present a more nearly flat absorption factor over the entire audio-frequency band, and so the "highs" are reverberated almost equally with the "lows." A set that is too completely enclosed by hard materials, however, is too reverberatory: that is, the time of reverberation is greater than it should be for the size of the set, and the percentage of articulation becomes low because of the overlapping of spoken words and their many reflections from the walls.

As a compromise the next sets were built partly of soft and partly of hard materials. This was not the solution of the problem, though, because strong

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This is the Third and Closing Article in Mr. Felstead's Series On the Making of Sound Pictures. These Articles Present a First Hand Account of the Present Technique of Sound Effects Recording in the Making of Moving Pictures

high-frequency reverberation would be found to come from certain angles in the set and none at all from other angles. When considerable recording was done in the same set and the mike was moved to several different positions, rather peculiar results were often obtained. In some places, the set would be very "boomy," due to the presence of considerable sound-absorbing material; and in other spots, the high-frequency tones were over-emphasized because of reflection from small areas in the walls made of hard materials and not solidly supported. These small panels resonated at certain high frequencies and threw out extremely strong reverberation when tones of those particular frequencies were sounded. An example of this phenomena is seen in the case of two violins having strings that are tuned exactly alike. If these violins are placed several feet apart and the string on one is plucked, the corresponding string on the other violin will be also set into vibration. This is termed "sympathetic vibration," and is due to the resonance of the two strings. A similar effect is encountered in sound sets when panels of hard materials are not firmly supported. These panels have each a natural period of vibration, or resonant frequency, which is determined by the physical dimensions of the panel and other factors, and at which frequency they can very easily be set into vibration. When the certain tone at which a panel resonates is sounded, the panel is thrown into sympathetic vibration with the tone and greatly augments it, producing distorted sound quality because of the over-emphasizing of this one particular tone.

Natural Materials

Finally, it was found that sets constructed of materials as nearly like those that would be used if the set were real produced the best and most natural results from the standpoint of sound. Economically, of course, it is impossible to use all natural materials in the set; and so cheaper substitutes are used wherever it is possible to do so without impairment to sound quality or photographic value. To reduce the weight and cost of construction of the walls, they are now almost universally made out of three-ply veneer, or the equivalent, strongly supported so that they will not be "drummy," or resonant at low frequencies. Real doors of light weight are used. This provides a set that is quite "live," but because two of the six sides of the set are open—namely, the roof and the front—almost exactly the right amount of reverberation is produced to simulate normal sound conditions. In other words, the reverberation produced by a sound in this four-walled set (three walls and a floor) seems the same to a monaural recording system as the reverberation produced by the same sound in a six-walled room would seem to binaural human hearing. The amount of reverberation in the sounds recorded must not be too great because there is a second, though lesser, set of reverberations in the theatres in which the sound is later reproduced. These two sets of reverberations add together and produce a rather bad effect if either set is too great. However, most theatres are now heavily sound-proofed to prevent excessive reverberation.

Sound-Proofing

Large folding baffles, like Japanese screens, made of sound-absorbing materials, such as rock wool, are often used to reduce the amount of reverberation in a set by adding more damping. They are placed around the set at the different points where they are needed, but out of sight of the camera. Sometimes hard baffles are also used for certain purposes. Padding is laid on the floor wherever it is possible to use it without it being seen, so that the footsteps of the actors will not be disturbing. Raised floors that are to be walked on must be solidly constructed and supported in order that they will not sound drummy. A wooden floor of double thickness with sound-proof material between the two layers of boards is often used for this purpose. Likewise, large parallel hard walls have to be watched or they will pick up certain audible frequencies and bounce them back and forth, producing "standing waves." Also, supporting beams must not be placed too far apart, or the space between them will be such that it will resonate at some points within the audio range. The incandescent lamps used in lighting the set must likewise be watched carefully so that they are not placed in such positions that their reflectors reflect certain sounds strongly against the microphone. There are

Fig. 2. Shooting a desert scene in "Hell's Angels."

many other similar things that experience will teach the monitor man to watch out for.

Before we go into a discussion of the practical side of monitoring work, it might be well to describe briefly the monitoring equipment used with the portable sound trucks. This equipment is mounted in a small trunk. Cables are provided so that it can be used in or on top of the sound truck, or at a reasonable distance from it. It may be noted in Fig. 4 that the upper part of this trunk contains two, three-position mixing panels, the same as those used for channel monitoring. Just below these panels are six key switches that control the filaments of the tubes in the condenser microphone amplifiers. Below them are two meters—the left-hand one is the volume indicator extension meter, and the one on the right is the filament voltmeter for the condenser transmitter amplifier tubes. To the right of this voltmeter is the filament rheostat, and to the left of the other meter is the main volume control potentiometer. The box between the meters contains the fuses for the condenser microphones. Six large jacks to the left and below the meters are for the microphone cables, one of which can be seen plugged in. Two other jacks to the right, which also have plugs in them, are for the cables that connect the monitoring apparatus to the amplifying and recording equipment in the sound truck and to the truck batteries. A one-tube booster amplifier is mounted inside the monitoring trucks. Portable monitoring is done by means of special headphones, which have a very flat frequency characteristic over the entire band of frequencies that is normally recorded. An intercommunicating telephone and hand-set may be seen in the foreground Fig. 1. Except for the arrangement of the equipment, monitoring on a sound truck is practically the same as it is in a portable monitor booth or permanent monitor room.

Microphones

Condenser microphones are used exclusively in sound motion picture work as they are more rugged than carbon microphones and have not the characteristic carbon hiss. These condenser microphones are made up of tiny condensers, called condenser transmitters, coupled to suitable one- or two-stage amplifiers. The whole assemblage is termed a condenser transmitter amplifier, or C. T. A. It has the advantage that it puts the gain at the point in the recording system where it is most valuable. Monitor men use whichever type of C. T. A. is better suited for the work at hand, and for difficult shots they often use both types at one time. The two-stage C. T. A. is always employed, of course, when extreme sensitivity is required, particularly when whispering or distant conversation is to be recorded. Some trouble has been encountered from noise in these two-stage mikes, due mainly to moisture collecting on the resistors, but that difficulty is being gradually overcome. When in use, the microphone is usually hung on a portable, counterbalanced boom, called the "mike boom."

Microphone Placement

Some monitor men favor but one microphone for recording dialogue and music. Others are addicted to the use of several microphones. There are good things to be said for both methods —the choice depending on the monitor man's preference and experience. It is often difficult to handle action that is spread out over a large set with one microphone. On the other hand it is not easy to control several microphones at the same time, or to fade smoothly from one microphone to another when following progressive action. If the microphone is to be the ears of the imaginary person whose eyes are formed by the camera lens, it is evident that the use of two or three microphones simultaneously or consecutively on a set is not at all desirable because that would be disrupting the relationship between the eyes and ears of this fictitious person—and that should be a fixed quantity. Without doubt, better results are secured as a rule from single-mike recording when the microphone position for each set-up is carefully chosen. There are cases, though, where the use of two microphones is desirable, such as when a close-up shot is made of two persons talking together with a noisy crowd for a background. In this case one mike is placed in the foreground for the close-up conversation, and another is hung in the background to pick up the crowd noise. That makes it possible to get a nice balance between the dialogue and the crowd noise without much difficulty. Where the crowd noise is quite heavy, it is often well to use a two-stage mike for the dialogue and a single-stage mike for the noise. That helps to raise the dialogue to the proper level above the background noise. A similar setup is frequently used when an orchestra or band takes the place of the crowd.

Fundamentals

The secret of monitoring lies in this: maintaining the correct relationship between the position of the camera and the lens system used on it and the position of the microphone, placing the microphone and arranging the baffles on the set so that the proper balance of direct and indirect sound to create the illusion of reality will be obtained, and keeping the recorded sound at a consistent level throughout the picture. These are the three commandments of the monitor man.

There is one other point that the monitor man must not overlook, and that is to watch constantly that the microphones do not pick up outside disturbances; such as, camera gear noise, sputtering from the arcs when "hard" lights are used, sounds from off stage and from the people working on the picture, and a-c. hum from microphone cables running parallel to power wiring. Cameras are now almost always enclosed in sound-proof cases, called "blimps," which greatly reduce the noise coming from that source. On location in the open it is necessary also to watch for wind noise, noise from the portable electric generating plants, and for distant sounds such as train whistles and airplane motors. Noisy amplifiers in the main recording system are another common source of concern.

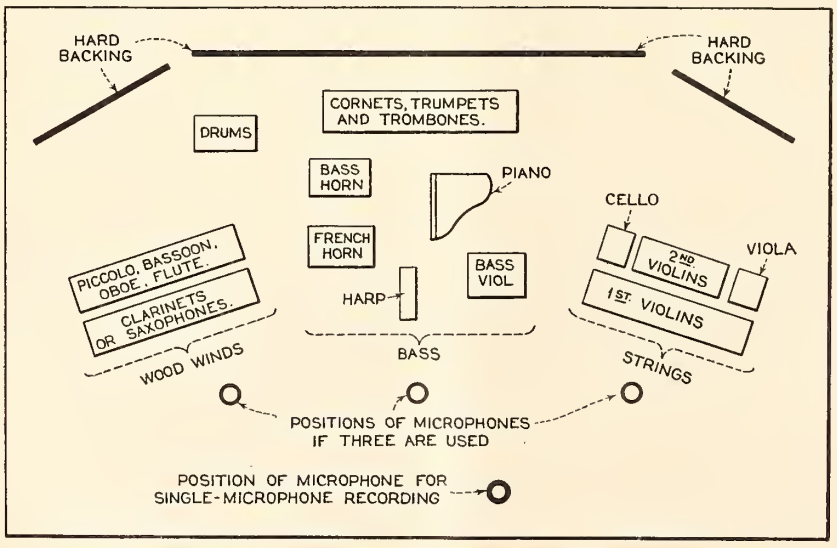


Fig. 3. Placement of instruments and microphones in recording room.

There are three main types of "shots" used in motion picture photography. They are called the "close-up" or "close shot," the "medium shot," and the "long shot." The close-up usually shows a single person from the waist up, or just his head. A medium shot generally takes in two persons and a portion of the set. A long shot reveals the whole set and the action taking place in it.

The usual positions of the camera relative to the action for these shots is evident from the titles, although even that varies with the size of the lens used on the camera, as has been explained. For a close-up the camera can be used near the action with a two- or three-inch lens, or at a little distance from it with a four-inch lens. The photographic result is practically the same in both cases. Regardless of that, the microphone should be hung close to the actor for a close shot, so that the sound will be recorded at the proper level, and the ratio of direct to indirect sound will be high. Usually for a medium shot, the microphone is hung some five feet in front of the action, between the camera and the actors and just high enough to be out of range of the camera lens. Care must be taken that the shadow of the hanging microphone does not intrude itself into the picture.

If a long shot is being made with a thirty-five or forty millimeter lens on the camera, the microphone is generally hung back near the camera and just a few feet in front of it. This position allows the microphone to pick up the reverberation from the four sides of the set, and so more indirect than direct sound is received by it. There is no fixed rule for the relationship of the positions of the camera and microphone because of the various sizes of lens used at will on the camera. The monitor man will have to learn for himself how best to obtain the proper relationship for each individual set up.

The placing of the microphone becomes much more difficult when, as is often the case, all three shots—the close-up, the medium shot, and the long shot—are made at the same time. This puts the monitor man in a rather trying situation, because the director expects him to get the proper sound for all three shots at one time. Most action is photographed twice as a precautionary measure. During one take, the microphone can be hung in the proper place for the medium shot. On the next take a microphone in position for close dialogue can be used to match the photography of the close-up camera. Then the monitor man will have to trust that the cutter uses the right sound track with the action from each camera. The long-shot photography will have to be matched with the medium-shot sound at a slight loss in realism. It is rather hard to hang the microphone in situations like this so that it will be out of range of all three cameras.

Occasionally a dummy chandelier is suspended in such a position that it shields the microphone from view. A little ingenuity when three cameras are used at one time will often save the monitor man worry.

Following the Sound

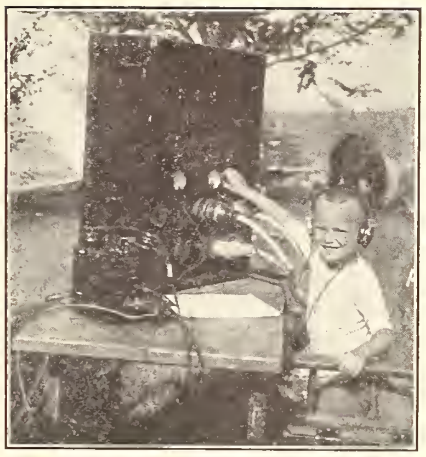
When action on a large set moves some distance, there are two usual ways of following the sound of the voice, if the camera is being "panned" to follow the action. Of course, if the camera is stationary and the action is moving away from it, the voice should not be followed by the microphone, but should be allowed to grow fainter with distance. When the camera is being actually moved to follow the actor, the boom carrying the microphone should likewise be moved in harmony with it so that the picture-sound relationship will remain the same. This is termed a "perambulator shot." It is necessary that the microphone cable be held up off the floor in order that it will not make a scraping sound when it is moved. Sometimes the microphone is hung from a long rope and swung in the proper direction by another rope tied to it.

However, when the moving action is followed by changing the focus of the lens on the camera the sound accompanying the action must be followed and maintained at the same level by having several microphones concealed along the path the action takes, and "fading" by means of the mixer dials from one microphone to the next as the action progresses. This arrangement keeps the direct-indirect sound ratio more nearly correct than if one mike were used and the sound level raised as the action recedes from it.

Sound Perspective

Obtaining the proper sound perspective is also of the greatest importance in monitoring. By that we mean that if the action seems to be in the next room the sound from it naturally should appear to come from that room. If a door between the two rooms is then opened the sound should become correspondingly louder. If the action then comes in through the door the sound should increase proportionately in volume. When a "fade in" or "fade out" is done by the cameraman, the sound should accordingly be faded in or out by the monitor man.

Scenes are rehearsed a number of times before being taken. This is to enable the actors to learn their roles, to permit the cameraman and electricians to obtain the proper lighting of the set, and for the monitor man to secure the most suitable position for the microphone. Before the take is made, the cameraman and monitor man have to give their okays to the director. Sometimes a wax record of the sound is made during a rehearsal, and played back to the director and monitor man so that they can determine how it will sound.



(Photo courtesy Universal Pictures Corp.)

Figure 4.

"Play backs" like this are practically always made when music is scored, to enable the musical director to obtain just the right effect. The monitor man and director go to one of the studio projection theatres each morning to see and hear the "dailies," or "rushes," of the previous day's shooting. They determine then whether or not the work has to be done over again.

Scoring

The scoring of music, or the making of "orchestrations," is one of the most delicate operations that the monitor man has to perform. As in dialogue recording some monitor men prefer one-mike, and others prefer three-mike recording. The successful recording of an orchestra depends upon the proper arrangement of the musical instruments to secure the most pleasing sound balance. Generally the arrangement of the orchestra is much the same as it would be on the stage, with the microphone taking the place of the audience. The reverberation constant of the stage in which the scoring is done can be quite a little higher than that of a stage used principally for dialogue recording. To secure this effect a backing made up of a wall of hard material is usually placed behind the orchestra. Sometimes a heavy rug is placed under the microphone, or a cloth curtain is hung behind it, to take the place of the damping afforded by the missing audience. Whether one- or three-microphone recording is used, the arrangement of the musicians is very much the same. This is often varied, of course, to suit the musical ear of the individual monitor

(*Concluded on page* 18)

Radio Television is Really Here

By Austin C. Lescarboura
Mem. A.I.E.E., Mem. I.R.E.

If Entertainment Value Is the Criterion of Practical Television, the Basis of the Television Industry Is Now At Hand, Waiting for the Merchandising Touch

A FEW evenings ago the writer sat in the library of Allen B. DuMont, chief engineer of the DeForest Radio Company, in his Montclair, N. J., home. Mr. DuMont wanted the writer to check with him on the entertainment possibilities of present-day radio television or radiovision.

About a year and a half ago, Mr. DuMont built a home-made short-wave receiving set, together with a resistance-coupled amplifier, as a means of tuning in and amplifying the radiovision signals. Also, he secured one of the Jenkins radiovisors taken from regular production. These two units have served to keep him posted as to what is going on in radiovision circles. He has kept a log of his observations for the past two years. The log is really a day-to-day history of the progress of the struggling art and must eventually be an important historical document.

The pictures were a revelation with regard to the entertainment value of radiovision. Heretofore, the writer had seen the usual demonstration, showing a close-up of a human being with enough detail to permit of ready recognition. But the picture seen the other evening not only could be recognized but possessed real story-telling characteristics. First of all, there was a synchronized sight and sound presentation of two comedians telling jokes, singing songs, and playing an accordion; then came a girl singing a television song, followed by a man who came to help her with the song; a bit later a series of prominent personalities was thrown on the screen, which could be identified for the most part although the writer must confess that he missed out on the close-up of Orville Wright for the reason that he does not know that face quite as well as he knows Mussolini, Edison, Helen Wills and others prominent in the public eye; and finally, we had a movie thriller reminiscent of the nickelodeon days of the nascent motion picture. All in all, it was an enjoyable show, although there were certain difficulties at times by way of extreme interference of other radiovision stations. During the evening, we tuned in the Jenkins television station, W2XCR, at Jersey City; the DeForest television transmitter, W2XCD, at Passaic; the Jenkins station, W3XK, outside of Washington, D. C.; and finally, some unknown signals which later proved to be those of the NBC transmitter in New York City.

Importance of Picture Detail

Any discussion of television possibilities always comes down to a question of definition. The experimenter or the engineer may be quite content with a flickering silhouette appearing on the screen, for the reason that such a mind knows the enormous difficulties by way of reproducing an image, and therefore secures the kick out of the technical achievement. On the other hand, the lay mind may be little interested in the means employed, taking the final results on the screen as the sole criterion of the worth of radiovision. Consequently, the entire matter, as frequently pointed out by radio leaders, is a question pure and simple of definitions.

The pictures reproduced under typical home conditions in the test just described contained a surprising amount of detail, even though they are of the 48-line, 15 pictures-per-second category. We have been led to believe in the past that 48-line pictures are comparable to a 48-line half-tone, which is even coarser than the usual 65-line screen of the newspaper. That is to say, if we were to take a ¾-inch square of a typical 65-line newspaper half-tone picture, we would obtain about the amount of detail which is present in a 48-line radiovision picture. Actually, this is a misconception of the entire technique. In the first place, while it is true that the pictures are being scanned in 48 horizontal strips, the fact remains that we are not dealing with 48 elements from left to right, but, rather, we are dealing with delicately and gradually variable lights and shadows across each horizontal strip, rather than 48 dots or picture elements. Therefore, we are dividing our picture only in the vertical plane, and not in the horizontal plane. We are securing excellent detail with half-tone values from high light to shadows, from left to right, although our picture may be divided into 48 strips from top to bottom.

The Pickup

The limitations of the 48-line screen heretofore criticized seriously, have been in large part due to numerous interdependent factors rather than to the basic principle involved. For one thing, pickup apparatus in the past has been very much at fault. Even when using the film pickup, there was failure to scan in a mathematically precise manner. Therefore, we have not secured the proper pictorial values for the 48 strips constituting each picture flashed at the rate of 15 pictures-per-second. Also, our amplifiers have not given us a sufficient range of frequencies so as to secure proper pictorial detail. Again, modulation of the transmitter has been very much at fault, so that whatever may have been picked up with a crude pickup and amplifier, has not been properly impressed on the out-going carrier wave. Then, at the receiving end, there have been many poor links further to cause loss of detail in the intercepted pictures. By spending many months in checking over

each detail and making it as perfect as possible, the engineers have been able to obtain a surprising amount of detail from the 48-line technique. Furthermore, the engineers are only using about 13 kilocycles of the total of 100 kilocycles available in the usual broadcast radiovision channel.

Entertainment Value

Since any discussion of radiovision gets down to a matter of definitions, it becomes necessary at this point to state a conception of reasonable entertainment value, so as to provide a yardstick whereby to measure the present possibilities of radiovision. By fair entertainment, we mean the telling of a story of real interest, which can be followed without the exercise of extraordinary imagination. If we must turn to a parallel, we might mention the motion picture screen. The present-day theatre shows the animated cartoon on the one hand, which conveys an excellent story in a grotesque manner, but with very high entertainment value. On the other hand, there is the highly artistic photoplay with excellent photography together with the sound accompaniment, telling a story with practically complete detail. In the case of the present radiovision presentation, the art is approximately halfway between these two extremes of the screen. Instead of the simple silhouette or again the close-ups of heads to which radio television was limited some six months ago, we now have long shots of complete scenes, including as many as a dozen persons, with about the same detail as was available in the first home-movie picture presentations. There is some flicker, due to the 15-pictures-per-second rate, as well as the 48-line scanning which weaves a pattern of coarse and apparently horizontal strips. If the film at the transmitting end is not carefully selected, there is a considerable loss of detail in the case of elaborate scenes with rather flat lighting. However, if the film is carefully selected, it becomes possible to present a really complete picture, which causes no strain upon the imagination of the lookers-in.

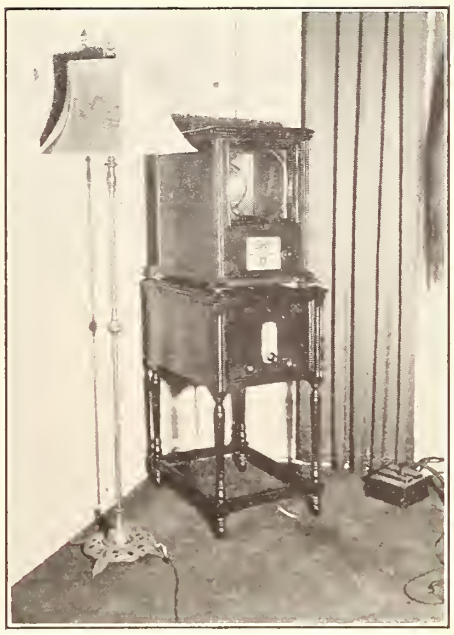
Standard Film

Recently, the DeForest engineers have been broadcasting standard motion picture film without any changes whatsoever and without deletion of scenes. Consequently there are some excellent scenes, while there are other scenes not quite so good due to everything being included in the radio movie presentation. For instance, on the occasion of the writer's visit, a film being transmitted included several so-called moonlight scenes, blue tinted form on the film at the transmitting end. Needless to state, such film is hardly suitable for any kind of presentation, much less for radiovision pickup. Otherwise the scenes were well detailed, so that the action could be readily followed. To be more specific, one scene represented an auction sale in which various articles were put up by the auctioneer. Such items as a bottle of liquor, an old trunk, clothes, collars, ties and other things could be readily identified, even when the scene included at least a dozen persons. The liquid in the bottle could be plainly seen in the hands of the auctioneer, in a waist-high closeup. Another scene depicted three automobiles in a chase, one being a taxicab. It was easy to follow the chase of the three cars, and to identify each as to its particular make, which requires a fair amount of detail in a long-shot picture including three cars. The black-and-white taxi could be readily identified, and it was almost possible to read the sign on the side. To the author's way of looking at the situation, the pictures are approximately on a par with those of the old nine-millimeter film employed for home movies several years ago, when magnified to a considerable degree so as to show the imperfections.

Program Material

From an entertainment standpoint, it is now largely a question of selection of suitable program material. The material may take three different forms: first, the film, which may be either regular theatrical film or special film made with the requirements of television foremost in mind; direct pickup of subjects in the studio, making use of the flying spot illumination of the subject and suitable photoelectric cells; and lastly, the direct pickup camera, which, scanning the subjects in broad daylight or artificial illumination, can be used practically everywhere, including out in the field.

Analyzing the three possibilities just referred to, we come to the first or film pickup, which, for a long while to come, will be found to be the backbone of the radiovision program, just as the automatic piano and phonograph were the foundation of the sound broadcast programs in the early days. A good deal of old and new film is available, so that the radiovision broadcaster need not fear a dearth of program material. However, unless original film is secured, or at least in a reasonable proportion to the total amount of material presented over the air, the lookers-in are not going to be satisfied for long, after their first curiosity is satisfied. However, it is relatively inexpensive for the radiovision broadcasters to have special film prepared for their requirements. The radiovision presentation of today must not be judged strictly from the standpoint of entertainment value, for the reason that the television broadcasters are for the most part experimenting with transmitters, receivers, and general atmospheric conditions, without particular regard for the entertainment end of their work. But there is a great danger with film pickup of repeating the same subjects over and over again.



Complete home radiovision equipment, comprising special receiver in table form, and cabinet radiovisor

Flying Spot Pickup

The flying spot studio pickup is an ideal method, particularly as a supplement to the film pickup. Thus the Jenkins studio in Jersey City is a meeting place for speakers, musicians, singers, and others who are willing to aid the struggling television art at this time. Such talent as can be coaxed before the flying spot pickup, is not only scanned and sent over the air in pictorial form, but the voice or music can also be intercepted by a nearby microphone, so as to give a complete sight and sound presentation. The picture signals are sent over the W2XCR television channel on 149 meters, while the sound is amplified to the necessary degree and sent over a direct wire to the DeForest telephone transmitter, W2XCD, at Passaic, N. J. At the receiving end the broadcast receiver tuned to the lowest point on its dial brings in the sound accompaniment, while the television short-wave

receiver and scanning mechanism weaves the accompanying picture.

Due to certain pickup difficulties by way of flying spot scanning and photo-cell placement, it is not as yet practical to pick up as much detail as can be safely handled with the film pickup. Consequently, aside from close-ups or intimate portraits, the film method is more suitable on a strictly pictorial basis. On the other hand, in the case of prominent speakers, singers or artists shown in close-up form together with their sound accompaniment, the flying spot studio pickup certainly freshens up a program and presents the real reason for radiovision. It must be obvious that the mere reproduction of old film will never put radiovision where sound broadcasting is today. Just as the phonograph and automatic piano passed out of the sound broadcast picture some seven years ago, so must the old film be discarded when radiovision gets down to genuine entertainment.

The Camera

The direct pickup camera, while leaving quite a bit to be desired by way of detail, possesses perhaps the best entertainment value of the three methods. With this method it becomes possible to stretch the radiovision pickup to outside events. Thus in the case of the usual broadcast pickup of prominent persons, the radiovision camera may be moved up close to the microphones, picking up the visual half of the presentation. This is an invaluable feature, inasmuch as it gives the radio audience its eyes. It completes the job of the news broadcast.

Due to the use of short waves, the direct camera pickup used out in the field may perhaps go forth with one-quarter kilowatt or a one-half kilowatt portable transmitter so as to broadcast the programs direct. In fact, the Jenkins organization has done some excellent work in a half-kilowatt portable transmitter in the field. The problem of remote-control lines may not prove a serious obstacle after all.

Air Channels for Pictures

The one great handicap in the immediate exploitation of radiovision, as the writer sees it, is the question of a place on the air. The demonstrations he has recently seen have frequently been marred, particularly at night, by conflicting carriers and even conflicting modulation or what would be considered cross talk if we were dealing with sound rather than pictures. So far, it appears that the Federal Radio Commission has not given radiovision broadcasters the necessary wavelengths or frequencies with which to carry on their experimental work. At the Montclair demonstration, for instance, three distinct carriers were being picked up on a given frequency, resulting in the marring of the powerful DeForest signals from a transmitter only five miles away. The interference takes the form of horizontal and vertical lines superimposed on the pictures and ruining detail. In fact, it was only after ten o'clock in the evening that we were able to secure satisfactory pictures, after the transmitter in Washington and that in New York City had gone off the air.

The greatest handicap at the present time is the question of radiovision interference. It is absolutely impossible to put on good pictures if they are going to be broken up by conflicting carriers or images. Just how the Federal Radio Commission will work out this detail, is rather difficult to see, inasmuch as the 100- to 150-meter band for radiovision transmission carries exceedingly well, so that interference may take place at great distances as compared with the usual sound transmission. Nevertheless, no real progress can be made if serious interference exists between television transmitters. It is to be hoped that the Radio Commission will set aside the necessary frequencies or arrange to have the stations divide time so that pictures will not be marred.

System Now Practicable

In conclusion, the author does not agree with the leaders of the radio industry who persistently claim that television is five years hence. He firmly believes, following the demonstration he has seen, that there is real entertainment value in radiovision technique as it exists today, and that it is possible to put out suitable receivers and radiovisors at a cost within reach of the average family. Furthermore, he believes that radiovision can be made the salvation of the radio industry during the coming year. If a suitable radiovision broadcast service is established in various parts of the country, on a regular entertainment basis rather than the present experimental basis, the public will want radiovision equipment. The new industry is bound to follow in the footsteps of sound broadcasting, beginning with a great deal of home experimentation with many home-made outfits, a keen interest in the design and engineering end, and a tremendous amount of curiosity displayed in picking up pictures. There will also be a large part of the public which will want complete equipment, ready for use. The second consideration, following the establishment of a satisfactory, dependable radiovision broadcast service, is mass production so as to reduce the price of equipment to the point where it really can be sold. Until now, this feature has been most discouraging, inasmuch as such equipment as has appeared on the market, claimed to be practicable and was offered at a price far beyond what the public is willing to pay. It seems to the writer that someone must take the initiative. Someone must establish a satisfactory broadcasting service, placing the necessary programs on the air so as to create a keen desire for a means of "looking in." Someone must take a chance and place in production a sufficient volume of radiovision equipment, whether it be complete sets or kits or parts, so as to bring the price down to within reach of the average family. If these two things will be done during 1931, which seems quite probable, we shall see a revival of the radio industry which will surpass our fondest expectations.

Rather than preach the distant future of television, as many of us are consistently preaching the permanency of depression, it would be far better for the leaders of the radio industry at large to take the radio television situation more seriously, endeavoring to work out ways and means of getting this art on a real merchandising basis, thereby bringing real prosperity back to the radio industry.

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MONITORING SOUND MOTION PICTURES

(*Concluded from page* 15)

man. Naturally somewhat different arrangements of instruments are used for recording jazz orchestras and brass bands. Hard and soft baffles are generally used with orchestrations as an aid to securing just the proper effect.

When three microphones are used for scoring, one is placed for the wood winds, another for the violins and a third for bass. By controlling the three mixer dials connected with these microphones the monitor man can quite easily get the correct relationship between these divisions of the orchestra. The overall volume is then regulated by the main volume control. When a single mike is employed its position and the arrangement of the orchestra is much more critical, but the results seem to be worth the extra work as the effect is much more like normal binaural hearing. When it is projected, the sound from a one-mike job seems to be much more *unified*. However, monitor men are obtaining excellent results with both systems of scoring, although the majority are inclined toward the one-microphone method.

Practically all of the information on monitoring contained in the last two articles of this series applies to the making of phonograph recordings as well, particularly the part relating to monitoring orchestrations.

A Three-Element Glow Lamp for Sound Recording

By Verne T. Braman*

The Employment of a Third Element in Glow Lamps Overcomes Certain Difficulties Heretofore Experienced in Sound Recording

THE ordinary two-element glow lamp (gas discharge tube) consists of a glass, Pyrex, or quartz tube which contains rarified gases, and into which are sealed two electrodes, an anode and a cathode. If sufficient voltage be applied to the two electrodes, the gas will ionize and carry current, at the same time becoming luminous.

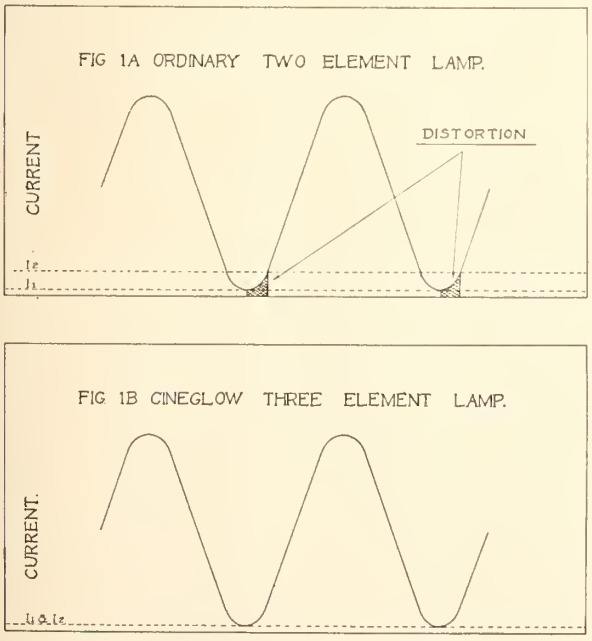
If now the voltage be varied up or down, the current will also vary, causing a variation in illumination proportionate to the variation in current. Thus, if the lamp voltage is modulated, its illumination is modulated proportionately.

This lamp may be modulated at sound frequencies and photographed through a slit onto film to make a sound track, such as is done in a number of recording systems.

Objections to the use of the glow lamp for sound recording have been given as lack of sufficient illumination for use with positive stock, short duration of life, lack of uniformity, and "blasting" when modulated at high volume levels. This last will be gone into more fully later.

Intense illumination can be gotten only by the proper combination of certain gases and vapors, which must be extremely pure and at the proper pressure. If all impurities and gases are not completely eliminated from all parts of the tube and tube elements, they are almost certain to manifest themselves later and cause early deterioration of the lamp. Likewise the nature of the gas and its pressure, as well as the material and purity of the electrodes determine the amount of sputter and the useful life of the lamp. Only by careful control of all of these factors can lamps be made with illumination sufficiently intense to expose positive stock, and with reasonably long life and uniformity.

* *Engineer, Blue Seal Sound Equipment Corporation.*



Current curves of two types of glow lamps.

Blasting at Full Modulation

If the voltage applied to the tube terminals be decreased, the current will gradually decrease until a voltage is reached where the current drops from a certain value (say I_1) to zero. Let us call this the extinguishing voltage. If, after extinguishing, the lamp voltage be increased, it will not ignite until a voltage somewhat higher than the extinguishing voltage is reached, which we will call the ignition voltage. At this point ionization of the gas is affected and the current suddenly rises from zero to a value (say I_2), which is greater than I_1.

Thus, when the voltage is modulated down to the extinguishing voltage and back again, the current will not exactly follow the voltage modulation, but will remain at zero until the ignition voltage is reached. Thus a hysteresis loop is introduced into our modulation curve. Fig. 1A shows how this can affect the current waveform at maximum modulation. I_1 is the minimum current before extinguishing and I_2 the current at ignition. The current remains at zero over a portion of the cycle, introducing a waveform which, due to the extremely sharp wave front or rise in current, is very productive of undesirable harmonics and distortion, causing harsh, raspy quality.

Fig. 2. Three - element glow lamp.

The Three-Element Tube

Obviously the only way to prevent this form of distortion is to make the ignition voltage equal to the extinguishing voltage. This is done by introducing a third element into the tube which allows an unmodulated ionizing current to flow at all times, independent of the modulated current flowing between the two normal electrodes. This unmodulated current from the third electrode keeps the gas ionized at all times, so that for the two normal electrodes the extinguishing voltage and ignition voltage are equal, and the hysteresis loop is eliminated. The resultant undistorted waveform is shown in Fig. 1B.

The distortion shown in Fig. 1A is mild compared with that of some tubes the author has measured. Certain impurities in the gas and improper spacing of the electrodes causes I_1 and I_2 to be much more widely separated.

Besides the "lag" in ionization because of the time required for the voltage to reach the ionizing voltage, there is also a time lag in the ionizing of the gas even after the ionizing voltage is reached. This effect tends to accentuate

the distortion previously described. By causing continuous ionization, the third element eliminates this effect also, and certain otherwise desirable gases and vapors which are sluggish in ionization can be utilized to advantage.

Fig. 2 shows the appearance and mechanical construction of a Cineglow three-element recording lamp.

The construction of this lamp is simple and rugged, and it is made entirely by machinery, thus eliminating the human equation which is not only costly but subject to non-uniformity.

The circuit for the three-element recording lamp is extremely simple. The two modulated electrodes are connected as in the standard two-element lamp circuit; i.e., the cathode is connected to the negative voltage supply, and the anode to the positive voltage supply through a transformer or inductance and a stabilizing resistance, the modulating voltage being introduced by the transformer or inductance in the usual manner. The third electrode is connected directly to the positive voltage supply through a very high resistance, say one or two megohms, which allows an unmodulated ionizing current on the order of 0.3 milliamperes to flow. This simple addition is enough to accomplish the desired purpose and eliminates all of the undesirable effects previously described.

Effect of Overload

Since the hysteresis loop has been eliminated and the ignition voltage made equal to the extinguishing voltage, obviously any over-modulation of the three-element lamp will result in only a flattening of the lower peaks of the waves, similar to the overloading of a vacuum tube, light valve, etc. It has been found that a certain amount of distortion of this nature is not noticeable in most forms of sound work, as practically all natural sounds are already very rich in the harmonics which are introduced, and a slight increase changes neither the character nor the quality of the tones. In addition to this, most complex waveforms consist of high frequencies "riding" on the waveforms of lower frequencies, so that the peaks of these higher frequencies are the first to become flattened, and the higher harmonics introduced are soon lost by being above the audible range as well as the transmission characteristic of the sound system.

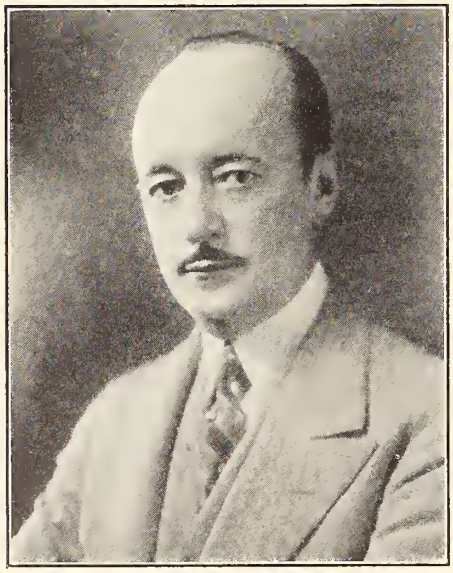
Reason for High Modulation Level

In sound systems our modulation level is limited at the lower end by ground noise and at the upper end by over-modulation. Since these limits are narrower than the volume range of sounds in nature, we must keep the average modulation reasonably high so that the weaker sounds are not lost in the ground noise. To take full advantage of volume range we must record with peaks on the verge of over-modulation. With the ordinary two-element tube this cannot always be done with good results, since full modulation results in the introduction of the previously described harsh and raspy quality, the distortion introduced bearing no harmonic relationship to the original sound. Thus the two-element tube must be modulated at a lower level, with corresponding loss in volume level and range.

With the three-element tube, however, full advantage may be taken of the volume range of the system with the knowledge that full modulation may be utilized, a slight amount of over-modulation on the extreme peaks being permissible. The use of a lamp capable of exposing positive stock also makes possible increased volume range and a reduction of ground noise. The net result is high quality sound recording with a greatly increased volume range and volume level.

RCA PHOTOPHONE GAINS

WITH more than 3,000 installations of sound reproducing equipment contracted for during 1930, as against slightly more than 900 to its credit at the beginning of the year, RCA Photophone, Inc., has registered more than a 300 per cent increase in business in its domestic and foreign commercial departments during the last twelve months. In addition thereto, RCA Photophone recording division in both domestic and foreign fields showed by far the greatest number of new installations of recording apparatus of any company engaged in the manufacture and distribution of sound equipment. In spite of the financial depression that affected all lines of business, RCA Photophone, Inc., under the leadership of Charles J. Ross, executive vice-president, has established a record that has been the subject of much favorable comment in all branches of the motion picture industry.



CHARLES J. ROSS
Executive Vice-President
RCA Photophone, Inc.

In commenting upon the outlook for 1931, Mr. Ross made the following statement:

"Continued refinements in recording and reproducing apparatus, the simplification of operation and the standardization of installations to reduce expenses, will receive primary attention during the coming year. Prices of equipment will not materially change, due to the high cost involved in the manufacture of standard equipment. Improvements will be made, however, and the number of models will be reduced.

"There are at least 10,000 unwired theatres of the smaller type in the United States and at least 5,000 of these will install sound reproducing equipment, in addition to several thousand others that will replace unsatisfactory apparatus with dependable equipment."

S. M. P. E. TO HOLD SPRING MEETING IN HOLLYWOOD

THE Spring meeting of the Society of Motion Picture Engineers will be held in Hollywood May 25 to 28, 1931, according to announcement by W. C. Kunzmann following a recent meeting of the Board of Governors.

O. M. Glunt, chairman of the Papers Committee, has already begun work in securing representative speakers and papers for the meeting.

The last meeting to be held in Hollywood was in the Spring of 1928 and with so many new developments brought about by sound in the studios since then, the coming convention is expected to be of great interest and value to the members of the Society.

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THEATRE ACOUSTICS

Kendell & Dasseville, of New York have opened a branch office at 1734 Ridge Avenue, Philadelphia. It is staffed with a complete sales, service and engineering unit and covers Eastern Pennsylvania, New Jersey and Delaware. Five houses, The Ridge, Grand, Jackson, Diamond and Ritz have already been acoustically corrected via The Kendell Method. Lewen Pizor, chain operator, is having eleven of his houses gone over; George Kline of National-Kline Poster fame, nine of his, and Comorford tops the list with twenty.

Wide Film and Third Dimension

By James R. Cameron

Mr. Cameron Believes the Present Economic Situation Will Delay General Introduction of Wide Film Pictures

ANOTHER of the wide film processes reached Broadway late in December. This time it is the Spoor 65 mm. developed for R.K.O. The management of the Mayfair Theatre advertised the new wide film as a "Natural Vision" production and from the advertising copy one might expect to see stereoscopic pictures.

In doing this, of course, R.K.O. follows the lead of the other wide film productions already shown. Each of these productions has been heralded as third dimension pictures.

It has been the writer's lot to see each of the wide film processes already shown, and we wish to go on record with the statement that to our way of thinking these pictures have as much third dimension as has Washington's picture on a two cent postage stamp. We are going to receive mail telling us that in certain spots in these wide film pictures there is an illusion of depth, and with this we agree, but this illusion of depth is in no way attributable to the wide film. One of the first subjects shown by the Fox wide film (Grandeur) was a picture of Niagara Falls, and the Spoor R.K.O. process has used these same Niagara Falls in the first public showing of that company's wide film.

In certain spots in both the Fox and the Spoor film a stereoscopic effect is obtained, but this same effect has been obtained in certain "travel" pictures on 35 mm. film practically since the inception of motion pictures. To the writer's way of thinking a much better illusion of depth was obtained in a 35 mm. picture made by Edwin S. Porter, who will be remembered as the director of the first motion picture with a story "The Great Train Robbery" and later as the manufacturer of the Simplex projector. The picture we refer to, curiously enough, happens to be another picture of Niagara Falls and was made, we believe, by Porter for Edison in the early days of motion pictures.

It has been claimed for the wide film, that due to using a 65 or 70 mm. film in place of a 35 mm. film, a wider angle camera lens may be used, thus approaching more closely the angle of human vision. In practice this does not work out. Approximately the shortest focus lens that can be satisfactorily used when using wide film would be a three inch, and this would give an angle of about 35 degrees, which is practically the same angle as that obtained when using a 1½ inch lens with 35 mm. film.

As we see it the width of the picture on the film has little or no bearing on the question of stereoscopic pictures. If the producers of wide film pictures intend marketing their product on a basis of stereoscopic films, then salesmen are going to have a tough time. The wide film has certain advantages over the 35 mm. standard in use today, but third dimension is not one of them.

We are ready to admit that certain of the motion picture critics on the New York newspapers in reviewing these pictures, have referred to certain shots having "an illusion of depth." One critic tells how the improvement in sound reproduction on one of these wide film pictures was due to the wider sound track, etc. The fact is this sound happened to be recorded on disc.

The picture at the Mayfair is one of those railroad dramas, in which the Chicago, Milwaukee and St. Paul Railroad gets some advertising. It is entitled "Danger Lights" and features Louis Wolheim, Robert Armstrong and Jean Arthur. The screen on which the picture is projected completely covers the stage opening, and renders the first ten rows of seats useless for perfect viewing of the picture. For a while we sat in the fifth row a little to one side, and there was both eye strain and distortion. We changed our seat repeatedly to try and get the "natural vision" but without result. All through the picture we noticed that the characters in the background were out of focus when the characters in the foreground were in sharp focus.

The scenes showing a locomotive and one passenger car making a time record run to Chicago were most impressive, as were the panoramic scenes taken outdoors.

From what we were able to learn during our recent stay on the West Coast and from recent developments in the East, the wide film is probably out, and activity on wide film and any other radical change is to be dropped for the time being. The present economic situation is the primary reason for this.

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SMALL THEATRE IN TIMES SQUARE SECTION, NEW YORK

BROADWAY'S first international theatre, to be dedicated to the presentation of first run foreign language sound motion pictures, in addition to the best product of the studios in this country, will soon be opened under the management of Sigmund Weltner and Nicholas Weiss, operating as the Signick Corporation. This theatre, the President, at 247 West Forty-eight Street, between Broadway and Eighth Avenue, one of the smallest of Times Square's legitimate de luxe playhouses, is now in the hands of RCA Photophone engineers who are installing that corporation's small theatre sound reproducing equipment, especially designed for houses having seating capacities of 1,000 and under. It will be the first small theatre on Broadway to have Photophone's new loudspeaker and directional baffle, which is said to come the nearest to perfect sound reproduction that has been obtained through the medium of a mechanical device.

The President theatre has a seating capacity of 300 and engineers in charge of the sound equipment installation, are said to be impressed with its excellent acoustics.

Microscopic Photography

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By Employing the Close-to-Visible Ultra-Violet Rays, a Gain of Nineteen Per Cent Over Visible Ray Method Is Obtained

▼

A NEW microscopic system which, using invisible, ultra-violet light, is able to reveal the nature of minute objects with theoretically 19 per cent greater detail than the best visible-light microscope can yield has been reported to the Optical Society of America by A. P. H. Trivelli of the Eastman Kodak Research Laboratories and Leon V. Foster of the Bausch & Lomb Optical Company, both of Rochester, N. Y. The microscope constructed by Mr. Trivelli and Mr. Foster is expected to be a further step in the process of permitting clearer pictures of microscopic objects to be made by biological scientists.

Photomicrography by ultra-violet light is not new, but experimentation heretofore has been conducted with ultra-violet light from a point in the spectrum comparatively remote from the visible. The system worked out by the Rochester men uses light closer to the visible and yet makes the indicated 19 per cent gain over visible microscopic systems. Use of light nearer the visible portion of the spectrum avoids the expensive necessity of using quartz instead of glass for lenses and in other ways is simpler than other ultra-violet microscopic systems. Also it permits the use of ordinary biological microscope slides with the object for examination mounted in Canada balsam. Previous ultra-violet micrography has required specially mounted slides because light of wavelengths previously used was too greatly absorbed by balsam.

Microscopy using visible light, according to Mr. Trivelli, has reached such a state of perfection that very little more in the way of improvement can be accomplished. The use of ultra-violet light, however, has brought forth many surprising results.

A demonstration of microscopic pictures obtained by visible light and by invisible light with the new microscope with its subject a grain of hollyhock pollen magnified 300 times, showed the minute object surrounded by nothing more than a vague, grey ring under visible light. The ultra-violet light picture of the same grains showed the ring resolved into a circumference of tiny spines previously not in evidence. Sharply increased detail showed in other ultra-violet photomicrographs of shells, leaves, and a section of calfskin.

The light source of the Trivelli-Foster microscope has a wavelength of about 1/70,000th of an inch, which is in the ultra-violet portion of the spectrum. Since ultra-violet light is invisible, the microscope's results are recorded on photographic materials. The system is so arranged that the object to be examined can be focused and viewed by visible green light and then, by a change of the light filter, photographed in greater detail by ultra-violet light.

Quoting Trivelli-Foster on the comparison with visible microscopy: "Photomicrography with radiation of 365 millimicrons (about 1/70,000th of an inch) makes available a considerable increase of resolving power (ability to show detail at high magnifications), or alternatively, if the resolving power obtained with visible light is sufficient, the use of the ultra-violet enables an increase of depth to be obtained by reduction of the aperture."

One phase of experimentation with the new microscopic system involved the discovery that sandalwood oil, used in connection with one element of the optical system, improved the resolving power because it absorbed much less of the particular wavelength of ultra-violet light used than did cedar oil, ordinarily employed.

A curious sidelight of the demonstration was a comparison showing the microscopic sections of the discodrellid worm made with visible light were clearer than with ultra-violet because the worm's surface contained a protective layer against ultra-violet rays.

THE SELSYN MOTOR

SELSYN motors are used for interlocking picture machines and dummies. As we use them they are three phase slip ring motors. The stators of all the motors to be interlocked are hooked to the supply, just as in ordinary practice, the corresponding slip rings are then connected to each other, that is, the inner slip ring on one rotor is connected to the inner slip ring on the other rotor, connection being made through the brushes, of course. The two other slip rings are connected in a similar manner. If one rotor is turned all the others that are hooked to it in this fashion will also turn, and in the same direction and in the same amount.

Wired in this manner the motors will not run of their own accord, but a different motor is used to turn one of the Selsyn motors. This one is then called the distributor and the other motor or motors follow it, or are driven by it.

ERPI is now putting resistances across the slip rings. The motors will then run by themselves, that is, without being driven by another motor. This is done so that the pickup will be better, and a smaller motor can also be used to drive the Selsyn motors. These resistances are of such a value that the Selsyn motors alone will drive the machines at about 70 to 80 feet per minute, the control motor taking the balance of the load and bringing the speed up to 90 feet.

These motors are also built to work on single phase, but these are not used in motion-picture work. The single phase motors have only two slip rings and the power supply is connected to these. The stators are somewhat similar to those of the three phase motors, but they form the secondaries in this instance, each of the three taps being connected to corresponding taps on the other motors to be locked together. This particular type is being used in the remote control of radio sets.

—*The Loudspeaker.*

CRABTREE ANNOUNCES NEW COMMITTEES FOR S.M.P.E.

APPOINTMENTS for the personnel of the committees to serve the Society of Motion Picture Engineers for the following year have been made by J. I. Crabtree, president.

Color, W. V. D. Kelley, DuChrome Film Systems, 6723 Santa Monica Boulevard, Hollywood, Calif.; Convention, W. C. Kunzmann, National Carbon Co., Cleveland, Ohio; Membership, H. T. Cowling, Eastman Kodak Co., Rochester, N. Y.; Papers, O. M. Glunt, Bell Telephone Laboratories, New York, N. Y.; Progress, G. E. Matthews, Eastman Kodak Co., Rochester, N. Y.; Publicity, W. Whitmore, Electrical Research Products Inc., New York City; Historical, C. L. Gregory; Sound, H. B. Santee, Electrical Research Products Inc., New York City; Standards, A. C. Hardy, Massachusetts Institute of Technology, Cambridge, Mass.; Studio Lighting, M. W. Palmer.

A Revolutionary Advance in Sound Recording

By Charles Felstead*

A New Device Which Silences Ground Noise Introduced in Sound Recording

ONE of the great bugaboos of motion picture sound recording has been the presence of "ground noise," or "background noise," and the difficulty of maintaining so low a level of noise that it will not interfere with the reproduced sound to an extent great enough to reduce the intelligibility of recorded dialogue and the quality of music. This appellation "ground noise" was given by sound engineers to the sputtering, grinding, gritty noise that has been present to a greater or less extent in the reproduced sound of all earlier sound pictures. It is an interfering sound somewhat analogous to the static that is encountered in radio reception. By taking extreme care in all the steps of recording sound, engineers have generally kept the ground noise below the point where it is annoying during dialogue or music; but during the portions of the picture where there was no recorded sound, the noise often became very noticeable and prevented the spectator's full enjoyment of these silent sequences. Whether or not the spectator was consciously aware of this noise did not particularly matter. The ever-present noise beating on his ear-drums served to irritate him and make him restless. Even though he was unconscious of the presence of the noise, he was constantly straining his ears to hear the voices of the actors and to catch the words as they rose out of and above this steady blanket of noise. Because this ground noise drowned out all faint sounds as a low blanket of fog covers up all objects near the surface of the earth and leaves only the taller objects showing clear, it served to place a limit on the lower end of the range of sound volume that might be recorded safely, reducing the volume range that would be possible if ground noise were not present. But now, through a clever invention, all of that is changed because the background noise is reduced to the point where it is no longer noticeable.

Noiseless Recording

This new device added to the Western Electric sound recording system produces what is to be known as the Western Electric new process noiseless recording system. The first test of this device was made at the Paramount Studio in the shooting of the picture, "The Right to Love;" and it proved so successful that the device has been adopted for use in the filming of all of Paramount's present productions. It was the thorough test that the device underwent in the recording of this picture that satisfied the electrical engineers who spent years in working to eliminate ground noise in sound recording that the device was satisfactory for general use. As a result of this the device has been made available to other studios equipped with Western Electric apparatus, and is being installed in their recording channels as rapidly as possible.

Previously the volume range of the Western Electric recording system was estimated to be approximately thirty to forty decibels, the exact range depending on certain recording conditions; but the addition of this new device has extended the range some six to ten db downward by almost totally eliminating the ground noise. The volume range of a sound recording and reproducing system is limited on the lower end by the point where the dialogue and music become so faint that they are covered up, or "masked," by the ground noise, and the volume range is bounded at the upper end by the point at which the recording or reproducing system or the film overloads. This device acts to increase the volume range by driving the ground noise to a much lower level. Even the faintest of recorded whispers will now become clearly audible; and directors will be able to obtain sound effects that formerly were impossible because all faint sounds were blanketed by the ever-present ground noise. Now when silence is required on the screen, the reproducing horns will be truly quiet, the attention of the audience will not be diverted by the extraneous popping and hissing sounds, and the dramatic effect will be accordingly heightened. Greater enjoyment of the picture by the audience will also be possible because the straining of attention to hear sounds that are so faint that the ratio of recorded sound to ground noise is low will no longer be necessary.

* *Sound Engineer, Universal Pictures Corporation.*

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PROJECTION COUNCIL TO MEET

THE annual meeting and election of officers of the Projection Advisory Council, will be held at 12 noon on February 11, at the Astor Hotel, New York.

The meeting will be followed by a luncheon at which a number of prominent motion picture executives will speak.

P. A. McGuire, of the International Projector Company, New York, has charge of the dinner arrangements.

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FILM MAKERS' PIONEERING SERVICE RECOGNIZED

ONE of the most important actions of the new Board of Directors of the Academy of Motion Picture Arts and Sciences, at a recent meeting was the unanimous election of George Eastman to become an honorary member of the Academy.

During the entire existence of the academy the board has been properly conservative in extending honors of this character. Only once before has an honorary membership been voted by the board, when it invited Thomas A. Edison to accept this distinction. Mr. Edison signified his acceptance at the time by wire, but owing to delays in arranging a convenient occasion for presenting the engraved invitation the event did not occur until a recent date.

The election of Mr. George Eastman also has been announced to the Academy.

Projectionists' Routine Tests

By D. C. McGalliard*

Careful Attention to Detail Will Avoid Service Interruption While the Show Is On

A CAREFUL motorist checks his gas and oil, and the mechanical condition of his car before starting on a long trip. It is equally important for the projectionist to thoroughly check the sound system daily. Such a practice will do much to forestall operating troubles. A large proportion of failures do not happen suddenly, but develop gradually and hence can be detected and remedied before they become serious. Testing should be started at least a half hour before the house opens so that irregularities, if found, may be corrected. Although the exact order of testing is not important, it is well to establish the habit of following the same routine daily. The procedure which follows is effective for determining whether the equipment is in satisfactory condition.

The system should be turned on as specified in the operating instruction book which is furnished with the equipment. If batteries are required for the operation of the system, their condition should be checked by the usual specific gravity tests.

Before operating the equipment it should be carefully oiled. Excessive lubrication should be avoided, as well as lubrication of parts that do not require oil. Excess oil is harmful because it runs off, gets on the film and spoils the picture and sound. Furthermore, the rubber insulation of the wiring deteriorates rapidly upon becoming oil soaked, causing noisy operation of the system.

The sound reproducing mechanism should be thoroughly inspected and cleaned. Use a pipe cleaner, bent double, and toothbrush for cleaning the sound sprocket, guide rollers, sound aperture plates and tension pad. Wipe off any dust and oil with a dry cloth. Do not scrape the film tracks or shoes with a knife or use an abrasive in cleaning. The film tracks should always feel perfectly smooth and polished to the touch. Run the finger tips over them to make sure that no rough spots are developing, due to dirt or hardened emulsion.

The exciting lamp must be clean and correctly focused as directed in the operating instruction book. Dirt on the exciting lamp, lens system, or in the opening in the aperture plate and tension pad may cause low volume and poor quality.

Current Values

Filament and plate current readings should be made to see that the values are within the specified limits. A tube may be defective if its plate current is either too high or too low while that of the other tubes of the amplifier is normal. In order to eliminate the possibility of failure during the show, any tube showing abnormal performance should be taken out of service and held for testing by the service engineer. Abnormal plate current of all tubes is indicative of abnormal plate voltage. If difficulty is experienced in locating or remedying the fault the service engineer should be called.

Sound-on-Film

In order to check "sound-on-film" reproduction, switch one machine to "film," open the sound gate, move the fader to step 8 or 10 (not higher, as damage to the receiver may result) then move a card rapidly up and down across the light beam in the open sound gate. This should result in a click being heard from the monitor horn every time the light is intercepted. The theatre horns should be turned off during these tests. The other machine should be tested in the same way.

Further tests should be made, using the theatre horns, at the same time checking the operation of the projector and reproducer mechanism. This should be done with sound film kept specially for testing. Piano, speech, and orchestra selections are most suitable. Someone qualified to judge whether the reproduction through the theatre horns is satisfactory, should now listen in the theatre.

Comparison of Units

When the first projector is started, sound should be heard from the monitor horn. With the theatre observer near the stage, each theatre horn should be tested individually to make sure that the sound is clear, quality good, and of full volume. Then stop the machine, re-wind the film and re-thread it; also thread a duplicate print in the other machine and starting both projectors simultaneously, compare their outputs for volume and quality by switching from one to the other. If the reproduced sound from both machines has been satisfactory, the equipment is ready for operation. If the tests indicate that the equipment is not in a satisfactory operating condition and the cause of the trouble cannot be eliminated then the service engineer should be called.

Disc sound reproduction should also be checked. Make a preliminary check of the reproducer and amplifying system by touching the needle with the finger. A clicking and grating noise should be heard from the monitor horn which will indicate that the system is operating. Identical test records should then be placed on the turntables, and the outputs compared for volume and quality as in film reproduction.

Strict adherence to this daily testing routine is fully justified by the definite assurance that the equipment is in good operating condition before the house is opened.

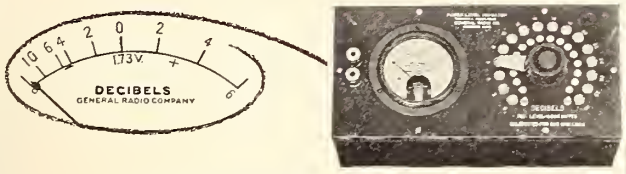
* *Director of Instruction Electrical Research Products, Inc.*

CHICAGO SECTION S.M.P.E. ELECTS OFFICERS

Election of new officers of the Chicago Section of the Society of Motion Picture Engineers has been announced. J. Elliott Jenkins is the newly elected chairman; R. Fawn Mitchell is the secretary and the Governors are Oscar B. Depue and Robert P. Burns.

Members of this Section now total 77.

DIRECT READING



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What is the Decibel?

By Gordon S. Mitchell

ONE of the most used, yet least understood terms in sound recording and reproduction is "decibel." Previous to 1923 the engineers of the Bell Telephone system used the expression "mile of standard cable" to designate a definite level of sound transmission —being the amount of sound heard in a telephone receiver after the actuating currents had passed through one mile of standard telephone cable. In 1923, the term "transmission unit" was adopted merely as a temporary term until the matter had been considered by all who had occasion to use a unit of sound transmission. For very obvious reasons, a unit of universal definition was desirable, and with this idea in mind, the International Advisory Committee on Long Distance Telephony in Europe was asked to devise such a unit.

There were two units proposed—one based on the decimal logarithm, and one based on e^2, of the Naperian system of logarithms. Certain European countries, already using the Naperian unit, were reluctant to change. Engineers of the Bell System, invited to sit in on the conferences, made the suggestion that the basic power ratios of the two systems be standardized as 10^1 and e^2, and that decimal multiples designated by the usual signs be used with either base. Numbers of the two systems corresponding to a given power ratio would differ by fourteen per cent. Inasmuch as the conference had reached a deadlock, it was finally recommended that the telephone systems of Europe use one or the other of the two approved systems of units, designating the one used by the name given it by the committee. The unit based on the Naperian system was given the name Neper, from the inventor of that system of logarithms, and the unit based on the decimal system was given the name Bel, from Alexander Graham Bell of telephone fame. Within a short time the Bell system in the United States adopted a unit which they called the decibel—this unit being one tenth of a bel and named in accordance with standard decimal nomenclature. The abbreviation db was adopted at the same time.

The mathematical definition of the decibel is given by the following equation;

$$db = 10 \log \frac{S}{S_o}$$

where S is the loudness of the sound under consideration and S_o is the loudness of a sound of identical pitch which is barely audible in acoustically dead surroundings. The loudness as expressed in the above formula is measured in any convenient unit of energy per cubic centimeter.

To arrive at a common understandable definition for the decibel let us consider a sound of any given pitch which is just audible. The loudness of sound reproduced in the usual theatre is about one million times this just audible sound. The ratio $\frac{S}{S_o}$ becomes $\frac{1{,}000{,}000}{1}$. The logarithm of 1,000,000, as given by the table of natural logs is 6, which makes the loudness level of the sound originally under consideration 6 x 10 or 60 decibels.

To convert back from the decibel level as read from the TU meter, a reverse process is used. Let us consider a level of 40 db. Dividing 40 by 10, a quotient of 4 is obtained. From the table of antilogs, we find that the number whose log is 4 is 10,000—which means that the sound which plays on a level of 40 db. has ten thousand times the energy content that a barely audible sound in the same surroundings would have.

The decibel, as evolved from the first "mile of standard cable" of the Bell Company, through the "transmission unit" as proposed to the International Advisory Committee, has been generally adopted as the standard unit of energy content for sound waves. The advent of talking pictures with recording of all types and varieties of sound has brought the decibel into common use by all connected with this kind of work. While originally intended for telephone usage, the decibel has taken its place in sound recording and talking picture reproduction and has become a term of common usage in the studio and the theatre.

TECHNICAL ASSISTANCE CONTRACT FOR THE SOVIET CINEMA INDUSTRY

THE Amkino Corporation, which represents the Soyuzkino (United Motion Picture Industry of the Soviet Union), announced recently the conclusion of a contract with Joe W. Coffman, president of Audio-Cinema, Inc., whereby the latter will become consultant in connection with the development of sound films by the Soyuzkino. Mr. Coffman left a short time ago for the Soviet Union.

L. Monosson, president of the Amkino Corporation, stated that the present contract is the first providing for American technical assistance in the Soviet motion picture industry. "The possibilities of sound motion pictures are keenly realized in the Soviet Union," said Mr. Monosson. "The motion picture is regarded as one of the most important means of educating the people of the country. At the same time the cinema occupies a high place among the arts. In order to further general cultural and, particularly, artistic development in the country, the Soviet authorities are anxious to apply the most advanced technical methods of sound motion picture production. It is likely that American technique may play a role in the Soviet motion-picture industry commensurate with that which it plays in other fields of the economic life of the U. S. S. R."

The Amkino Corporation sells and distributes in the United States films produced by Soviet motion-picture companies. It purchases for shipment to the U. S. S. R. studio and theatre equipment, raw film, and other motion-picture machinery and materials, and also American pictures. Copies of films purchased here are printed in the United States on American or Canadian raw stock.

Many of the Soviet films imported into the United States have won a distinguished place for themselves for artistic merit in respect to direction, acting and photography. Industrial and educational pictures of scientific value are also imported. A number of Soviet directors have been invited by American producing companies to direct pictures in this country. One of the best-known of these, Sergei Eisenstein, is at present connected with the Paramount-Publix Corporation in Hollywood.

Since its organization in 1926 the Amkino Corporation has released forty-two feature pictures and a number of news reels. Of the feature films one each was released in 1926 and 1927, eight in 1928, twenty-one last year, and this year through July, eleven.

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BOOK REVIEW

PHOTOCELLS, by V. K. Zworykin and E. D. Wilson, John Wiley & Sons, New York, 210 pp., illustrated.

This new book contains much useful information on the design and operation of photocells as used in various industries.

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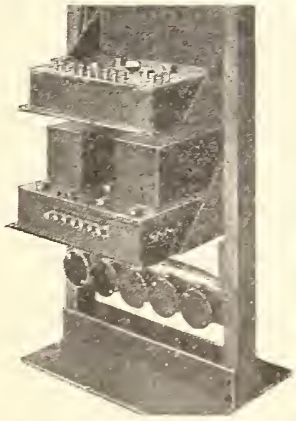

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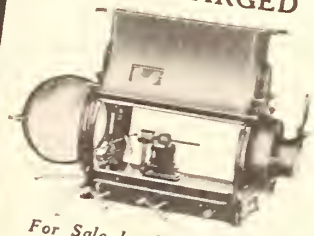

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New Developments and News of the Industry

CONDENSING LENS SYSTEM

A patent (U. S., 1783481) has been issued to Bausch and Lomb Optical Company, Rochester, N. Y., covering a condensing lens system for projectors. The system is the invention of Wilbur B. Rayton, of the Bausch and Lomb Company.

▲

SOUND DISTRIBUTING SYSTEMS

The Webster Electric Company, Racine, Wis., manufacturers of accurate electrical apparatus for over twenty years, reports a rising demand for their amplification system. Two large installations of Webster equipment have just been completed by their Milwaukee, Wis. representative, the Wirtz Company.

One of these installations indicates the trend of educational development, through the transmission of important study material and facts to classrooms from a central source. The Sheboygan High School, at Sheboygan, Wis., is now utilizing this method by means of Webster amplification.

▲

SUCCESSFUL SCREEN MODIFIER

The Vallen Electrical Co., Inc., Akron, Ohio, has developed a successful screen modifier.

The screen modifier is a perfected stage appliance, designed specifically, and essential to the proper presentation of widescope, magnascope, grandeur, and any size film on mammoth screens.

With the Vallen automatic screen modifier, a program consisting of wide film and narrow film presentations can both be projected on the screen to the best possible advantage, without any attention or manual effort to the modifying curtains. Unusual and unique close-up and fade-out effects, distinctly fitting to sound and scene, can be achieved with the screen modifier, and impossible to duplicate with any manually operated or temporary mechanism or device.

▲

MERCURY VAPOR RECTIFIER TUBES

Dr. Paul G. Weiller, the well-known consulting research engineer, of 28 Clubb Street, Bloomfield, N. J., has developed new designs of mercury vapor rectifier tubes which have many uses. These tubes may be used as power supply rectifiers for speech amplifiers used in talking picture work; for high voltage supply in broadcasting and for automatic devices operated by phototubes.

▲

SCREEN RENOVATOR

Benjamin Perse announces that The Sound Screen Cleaning & Renovating Co., at P-630 Ninth Ave., New York City, has developed a process that gives new life to faded, discolored and dirty screens of all types.

It is claimed that this process ofttimes brings a screen into better reflective condition than it was on original installation.

A very nominal charge is made, and if so desired, screens can be fireproofed without being removed from the theatre.

POLYMET ENTERS SOUND EQUIPMENT FIELD

The entry of this firm into the sound equipment field has been expected for some time. Widely known throughout the electrical and radio industries, Polymet products are now destined to become important factors in the newer field of sound.

Realizing the need for exceedingly wide safety-factors in equipment of this sort, Polymet announces its new line of equipment bearing the descriptive legend Polymet "Safety Margin" parts.

Polymet is well equipped to manufacture such parts. Plants of the company, each under the exclusive direction of a specialized engineer insuring strict adherence to standards, fabricate all the elements entering into the construction of these items. The Polymet plant at Winsted, Conn., makes the copper, enameled and insulated wire. The Easton, Pa., plant fabricates the coils, solenoids, chokes and transformers. The main plant, in New York, is entirely devoted to the manufacture of condensers and resistors.

Besides parts manufacture, Polymet also assembles complete amplifiers suitable for sound work of every sort.

▲

CONNECTION LUGS

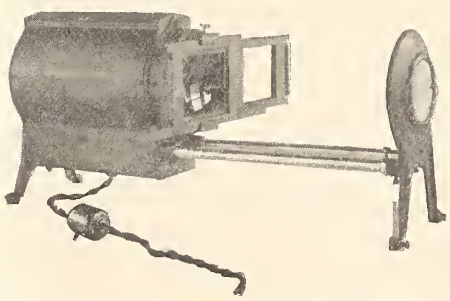
Hoffmann-Soons, manufacturers of Perfection Rheostats announce that a newly designed series of solderless, adjustable lugs, is ready for release. These terminal lugs, capable of handling all wire sizes from number 4 to 4/0 will be assembled on the new Perfection Rheostats at no additional cost.

▲

THE BESTOPTICON

The Best Devices Company, Cleveland, Ohio, is displaying the Bestopticon.

The Bestopticon has proved itself to be the ideal stereopticon for the theatre, especially where distance to the screen is



not over seventy-five feet. And not only for the theatre, for it is unusually popular with the lecturer for church and classroom use. It is high in efficiency.

▲

VITAGLO SOUND ON FILM

A. B. Chereton, president of the Vitaglo Corporation and designer of the Vitaglo light, announces the opening of a commerical sound recording studio at 4942 Sheridan Road, Chicago, Illinois.

The Vitaglo light marks a great advance in the recording of sound on film, in that it utilizes an entirely new principle of sound photography. The Vitaglo portable recording unit is sold outright to commercial producers and newsreel cameramen on a budget plan which enables the purchaser to pay for the unit in ratio to its earning capacity. There are no royalty arrangements to be entered into, the sale being made outright. The Vitaglo sound head may be attached to any standard camera which has been silenced for sound. The Vitaglo amplifiers are sturdy and rugged and lend themselves very well to the rigors of transportation.

The entire unit, stripped for action in the field, weighs only 150 pounds and may be carried in the rumble seat of a roadster.

▲

TYPE T PAD VOLUME CONTROL

The Central Radio Laboratories, 16 Keefe Avenue, Milwaukee, Wis., have available a flexible volume control known as the T Type Pad.

The T pad consists of one group of three resistances. Two offer constant impedance to the input and output circuits. The third is a tapered graphite resistance to give smooth and linear variation of volume.

These T pad volume controls are essential for efficient operation of a wide variety of circuits in the sound projection field.

▲

HEAD AMPLIFIER

The G-M Laboratories, Inc., Grace & Ravenswood Aves., Chicago, announce the development of an improved preliminary (head) amplifier for use with sound-on-film equipment. This amplifier can be used on all makes of sound equipment and because of its small size and the simplicity of installation can be used with either new or old equipment.

The complete unit is mounted in a steel service case, permitting the wiring through rigid or flexible armored conduit. The chassis proper is white alloy metal, offering a very attractive appearance. Electrically, the amplifier has a very flat frequency response characteristic assuring equal volume output at all audio frequencies. The tube support is of heavy cast-brass supported by four steel springs, eliminating the possibility of microphonic noise. Electrostatic shielding is accomplished by complete enclosure of all parts including tubes.

Other features include variable cell voltage control, which permits adjustment of the photoelectric cell output for best quality and minimum background noise; adjustable interstage gain control; jacks for testing cell voltage and plate current; on-and-off switch which controls all battery supply, and low "A" and "B" battery drain.

The overall gain of this amplifier is rated at 40 db. at the 500 ohm output transformer which may be connected directly to any standard fader.

Overall dimensions of the service box container are height, 12½ inches; width, 9 inches; depth, 6 inches.

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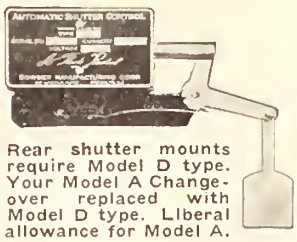

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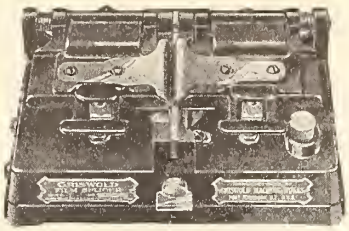

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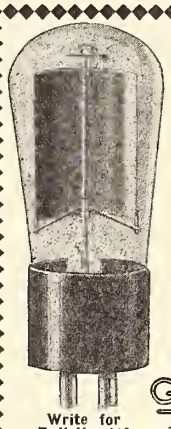

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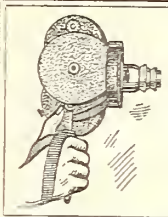

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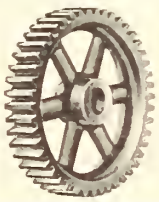

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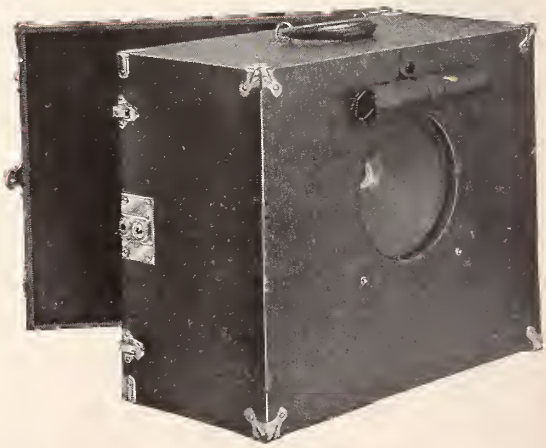

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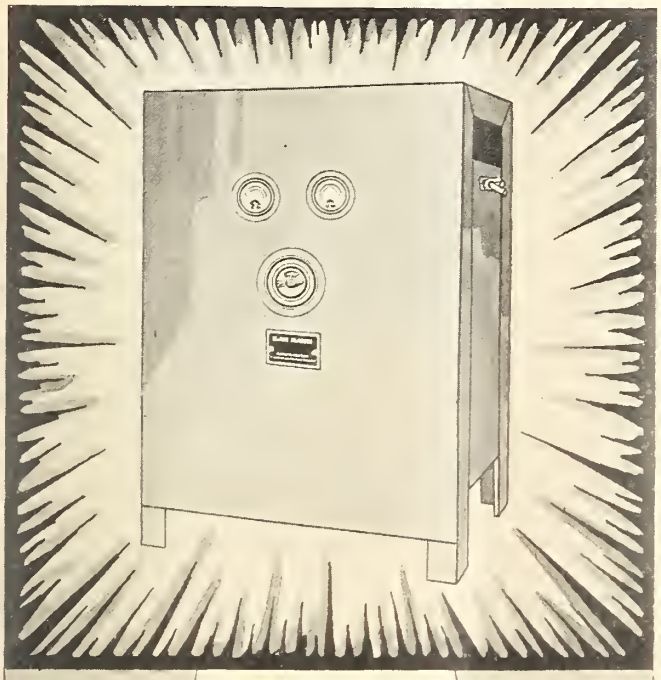

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Editorial

February, 1931

COMMERCIAL TELEVISION

IT is an impressive tribute to engineers and to science laboratories that commercial projects for exploiting and marketing television are in the making. Television as a commercial enterprise does not exist as yet, but engineers are at work on it and that seems to be sufficient to convince promoters that commercial systems will emerge from the laboratories in due time.

The many who for twenty years did the inventing and the pioneer development work in radio have, since the events of 1921, had time to sense the advantages of coordinating inventive ability with business ability. In 1921, interests previously somewhat contemptuous of radio gathered up the scattered elements of the art, capitalized them, and put them to work to produce revenue.

Much of the jockeying with television as it progresses toward success is based upon the experiences of individuals, years ago, with radio. It would be a great thing if the hundreds of engineers who are now and who have been for the past few years struggling to wrest this new art from the stores of darkness, should be permitted to participate in the fruits thereof—with the Roxys and the Rudy Vallees.

At the moment there is much afoot which reflects keen interest in the possibilities of commercial television. The National Broadcasting Company, of RCA, and the Columbia-Paramount organization have been granted experimental permits by the Federal Radio Commission, and with 25,000 television receivers of miscellaneous makeup already in the hands of persons interested throughout the country, it is possible that television is about where radio was in the period 1915-1920.

▲

INDEPENDENTS INCREASE

OLD Man Economics has a way of shouldering in when an industry finds itself in that perplexing condition where enormous gross receipts do not automatically signify satisfactory net revenue.

In the moving picture industry with several producing major groups individually depending for success upon originality of product, ingenuity in presentation, aggressiveness and boldness in exploitation, it is natural that a time arrives when Dad Economics with his balance sheet in hand has a word or two to say.

One natural consideration has been the possibilities in the way of applying the chain store idea to theatres. Obviously, the tremendous costs of originality of product, scale of production and of exploitation may in some degree be circumvented where the producer controls the theatres. Control of zones of sales outlets permits of regulating various items of marketing costs, to the advantage of net receipts. At least this is the way it works out with chain stores.

In the entertainment industry, however, there appears to be an intangible element which, when some day minutely dissected may be discovered to be peculiarly a personal relation between the individual theatre patron and the ensemble which is the theme of the story, the art of the performer and the subtle environment of the theatre itself. The hero or the heroine of the story always does what the onlooker would do if he or she had the same opportunity. There is in this a spiritual experience in self-expression which perhaps may be chain-stored only with the most intelligent care, and with a never overlooked consideration for the personal, individual intellectual needs of the theatre patron.

During the eighteen months prior to October last, producer controlled theatres increased in numbers. Then, a recession set in. No doubt there were various factors which had a bearing on this recession.

As a sign of the times it may be stated that in the Philadelphia, Penna., territory there are at present 630 independent theatres compared with 590 in September, 1930, while producer-owned theatres now total 200 compared with 250 in September, last.

The economics of canned goods merchandising may not with equivalent revenue gain apply to the entertainment industry.

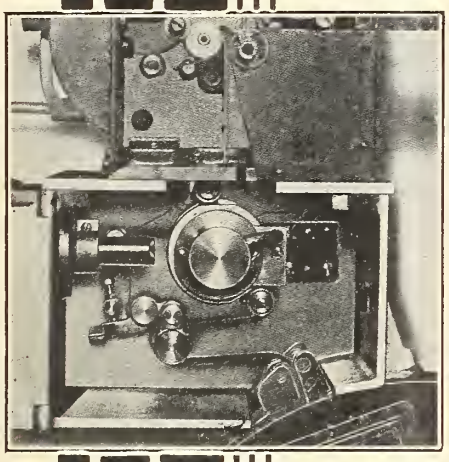
▲

MR. LASKY TELLS THEM

"HOLLYWOOD makes too many pictures," Jesse Lasky, producer, told members of the Academy recently. "So many theatres have to be kept supplied with changing programs that the total income isn't large enough to stand the costs of the individual pictures." There aren't enough good stories in the world to supply the annual demand, he asserted, declaring that whereas a stage producer need only present one to five plays a year, the motion picture producer must meet release dates with a production a week. "Hollywood has too many 'yes' men, but not enough creative artists who can do worthwhile work and meet the producer half way . . . ."

Donald McNicol

Editor.



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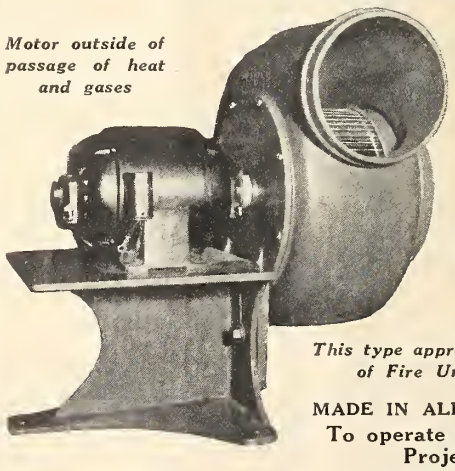

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Projection Engineering

FEBRUARY, 1931

Extending the Range of Pickup in Sound Picture Work

Photo courtesy RKO Radio Pictures Studios

Fig. 1. Pickup 42 feet away obtained across the top of a salmon trap in Alaska.

By J. Garrick Eisenberg

HERETOFORE one of the essentials for high quality microphone pickup in the recording of sound pictures has been that the pickup device be located relatively close to the source of sound, so that it will be within the beam of the higher speech frequencies upon which intelligibility so largely depends. Because of this well known "beam effect" the distance at which high quality dialogue may be obtained with an unaided microphone is limited roughly to within four feet from the source of sound. At greater distances quality falls off rapidly, due to the spreading of the upper frequency band with a subsequent attenuation of sound pressures at the microphone. Also, factors such as reverberation from walls, the acoustic properties of set and stage, etc., become more serious in proportion as the microphone is moved away from the source of sound. Accordingly, microphone placement in sound picture work has been held within narrow limits whenever high quality pickup was essential to the action.

▲

A Discussion on Microphone Concentrator Devices

This limitation imposes serious difficulties upon the process of motion picture production. Quite often the most desirable position for the microphone lies well within the field of the cameras, which of course is not permissible when photographing the action. A conflict between best camera setup and best microphone setup continually takes place, and in the nature of things, compromises must be made so as to satisfy, as far as possible, the legitimate demands of both. In this respect the camera possesses a very important production advantage in that while the unaided microphone can secure good quality of pickup corresponding to the close-up picture only when it is near the speaker, the cameras, by the use of suitable lenses, can photograph close-up and medium-long shots from the same setup without much difficulty. Placing the microphone outside the long shot camera lines in a setup of this sort results in an inadequate quality of sound pickup for the close views of the picture. In order to secure pickup sufficiently close to the action to obtain the proper perspective, it usually becomes necessary to move the cameras in for the close-up shot, the limited camera field permitting the microphone to be placed nearer to the action. It has long been recognized that a pickup device which would make it possible to obtain high quality sound at a distance corresponding, say, to a medium length camera shot, would be of considerable value to the industry by eliminating the necessity of making takes for close-up sound only, with a consequent saving of time and cost of production. Devices of this nature, whose function it is to concentrate the sound within a definite plane or beam and thus increase the range of high quality pickup of the microphone, have been developed for talking picture work at the RKO Radio Pictures Studios in Hollywood. Not only has the desired economic objective been attained by their judicious use, but in addition, an all around improvement in artistry of performance has been made possible, by virtue of the fact that the area of movement of the actors has been extended, resulting in a much more natural performance on their part.

Microphone Range Extended

Two types of microphone concentrators have been developed for this work, favorable results being obtained with both at distances of the order of 20 feet from the source of sound. Under exceptional conditions this distance has been increased to as much as 40 feet, and more, from the speakers. Advantages of such long range pickup

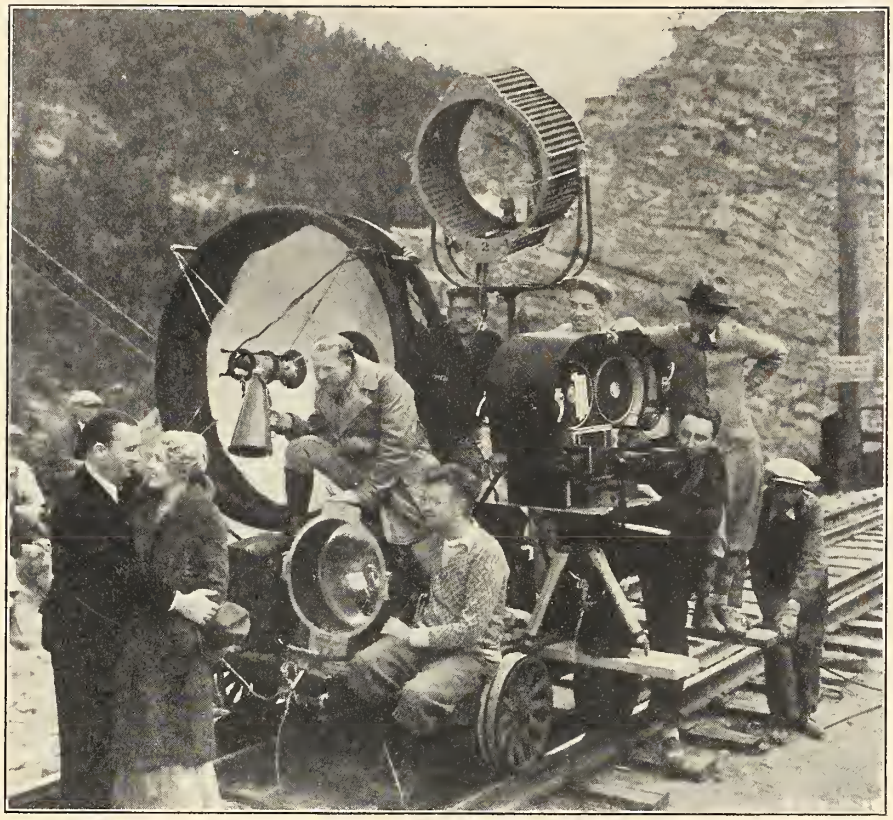

Photo courtesy RKO Radio Pictures Studios

Fig. 2. Rehearsing an outdoor "dolly" shot.

are at once obvious, particularly in the photographing of outdoor scenes of large scope where characteristic noises other than speech are to be recorded.

These concentrators take the form of open bowls mounted on suitable supports, their fundamental purpose being to act as collectors of sound waves. The concave surface of the bowl, which is of sheet metal, is designed so as to reflect all of the sound picked up to a focal region at or near which point of concentration the microphone is placed. The microphone transmitter is turned away from the source of sound and faced toward the reflecting surface of the bowl; sound issuing from the source strikes the reflector at various angles and is turned back towards the transmitter. An additive effect is thus secured, which is maximum at a certain point in relation to the reflector surface. One type of concentrator utilizes an open reflector curve corresponding roughly to a parabola of the equation $y^2=12x$. A second type makes use of the principle of an ellipsoidal reflector and utilizes a softer focus than the parabolic form. The diameter of the bowls varies between 40 and 60 inches. Means are provided for accurately sighting and orienting them in the lateral and vertical planes, and the devices are extremely flexible in operation. Sound originating outside the beam of the reflectors is sharply discriminated against. The bowl thus serves to shield the microphone from sounds occurring in a direction away from the scene of action, a useful property in limiting camera motor and other undesirable noises. A number of different mountings developed for use with the concentrators are shown in the accompanying photographs.

Mike Need Not Be Close-up

In one of these, Fig. 1, is indicated the setup for a scene made during the filming of RKO's "Silver Horde," the greater part of which was photographed in Alaska. The action takes place on top of a salmon trap, a structure of piling built out into deep water. These traps are designed simply to catch salmon, and without regard to their possible value as location atmosphere in motion picture production. Despite the apparent nonchalance of the crew in this photograph, it is a risky business juggling the necessary equipment atop the narrow ledge. Sufficient planking was laid along one side of the trap, however, to provide a working platform for the cameras, etc. Important dialogue occurs during the action which takes place in one corner of the trap at the extreme right of the photograph shown here; both close-up and medium-long shots of the action were required. In this case, cameras could not very conveniently be moved in for the close-up action. A parabolic type of microphone concentrator was mounted on the camera platform and centered on the action. Good pickup was obtained in this way over a distance of 42 feet, a rather exceptional instance made possible by the favorable conditions over water. The cameramen were thus enabled to make their various shots from the same setup, obviating the possibility of having to duplicate the setup in the studio later for the close-up action.

Unwanted Sounds Excluded

An example of the value of the concentrators in discriminating against interfering noises originating outside their beam is afforded in another RKO picture "Danger Lights," during which it was necessary to shoot some scenes in a railroad roundhouse. With open microphone pickup it was impossible to obtain intelligible dialogue at a distance of three feet from the speaker. By utilizing the directional properties of the concentrator, satisfactory dialogue pickup was made possible at much greater distances, the attendant noises being reduced to a realistic background. Fig. 2 shows a rehearsal for a scene in this production, cameras and microphone being dollied up on the actors to achieve a smooth fade into a bit of intimate dialogue. The noises incident to the movement of the handcar, etc., are effectively shielded from the microphone by the concentrator bowl. A fine sense of fluidity of movement is secured when camera and microphone can be mounted in this manner; an ideal perspective is afforded, the photographic eye and ear being in proper juxtaposition at all times. While it is possible to make a shot of this type with open microphone pickup also, two separate setups would be required for the medium and close-up views, and a great many more precautions for limiting extraneous sounds would be necessitated with a subsequent waste of valuable production time.

Dubbing Not Always Successful

Crowd scenes, where it is desired to pick up the lines of one or two speakers clearly, at some distance, and other outdoor shots entailing considerable movement over a large area, have in the past depended upon the "dubbing in" of sound after the action had been photographed. This artifice is at best a compromise, and not always a successful one. Good pickup can be achieved during the action in shots of this type by the use of microphone concentrators. Another valuable property of the device in outdoor work is its effectiveness as a break against wind interference. When the concentrator bowl can be turned with its reflecting surface away from the wind somewhat, so as to place the microphone transmitter in its lee, it acts as a shield against direct wind pressures. Wind interference is a frequent cause

of delay in outdoor shooting with open microphone pickup, sometimes holding up the production schedule several days.

Useful Also for Indoor Pickup

The use of microphone concentrators is not limited to outdoor work. Promising results have also been secured with the device indoors. Certain precautions are necessary when they are so used. Set construction must be of a "soft" nature acoustically and, also, care must be taken that the device is not pointed directly toward any large wall surfaces which may act as reflecting mediums. Reverberation and reflection of sound occurring within the beam of the concentrators are, by the very nature of its design, exaggerated in effect. These secondary sound waves are picked up and added to the original sound, the net result being similar to that obtained with open microphone pickup located a considerable distance from the source of sound in an extremely hard set. Observing the precautions mentioned, however, the device can be of considerable value for certain types of interior shots. For example, in covering a wide angle of pickup, as when two speakers are stationed approximately 180° apart and the action calls for considerable movement, two concentrator pickups can be used, each being focused so as to cover one speaker. In this way a number of cameras can be set up at the same time to obtain the various angles necessary for picture cutting purposes, and good pickup can be obtained from both speakers with due regard to the proper camera angle. The area of movement permitted the actors is also extended appreciably. With open microphone pickup at least two different setups would be required to obtain proper sound values for a shot of this type. Otherwise some sacrifice of pickup quality would have to be made for one of the speakers, since it would not be possible to cover both adequately, even with a microphone boom of the following-crane type.

Another case where such devices are of value for use indoors is in the following of continuous action moving through several rooms, the concentrator being mounted upon the camera dolly and moving along with it to cover a close-up of the dialogue ensuing. Numerous problems of a similar nature occur during production in interiors. The increased flexibility of pickup afforded by the concentrators offers useful assistance in their solution.

Size of Bowl

A definite relationship exists between size of collector bowl and its efficiency at different wavelengths. The lower speech frequencies, being made up of sound waves of considerable length, require a device of large diameter if any appreciable portion of their wavefronts is to be utilized. Beyond certain reasonable dimensions, however, such a device becomes unwieldy in production. It may throw long shadows across the area of action, interfere with the proper setting up of lights and cameras because of the large amount of space occupied, and in general, be difficult to handle. These reasons necessitate that some compromise be made with the most effective sizes possible. Concentrators having diameters between 40 and 60 inches are considered to be desirable commercial sizes.

Some loss of response at frequencies below 500 cycles occurs with these; a loss made more obvious by the intensification of sound pressures occurring at frequencies above about 2000 cycles. This increase amounts to an approximate ratio of 6:1 as compared to open microphone pickup at these frequencies. The exaggerated reinforcement of the highs may be modified, however, by altering the shape of the concentrator curve somewhat, and also, by throwing the microphone slightly out of focus with the reflector, thus sacrificing maximum sharpness of focus and obtaining a "softer" pickup effect. In practice, the microphone is placed about one-third off the true focal distance from its reflector. As may be surmised from these remarks, the pickup technique involved in the use of the concentrators is a rather special one. A discriminating ear is sometimes required to fit the concentrator characteristics to the type of pickup being handled. On a properly constructed set indoors, however, or in outdoor work an experienced recordist often can obtain a quality of pickup with the concentrators at a distance of twenty feet, which is difficult to distinguish by ear from open microphone pickup three feet from the speaker. It is usually desirable to place the concentrators at a point not further back from the action than the camera position.

Focusing the Microphone

The devices are focused accurately upon the source of sound by means of the sighting arrangements previously mentioned, the source of sound being considered as a target. For lateral focusing, a pair of sights quite similar to those of a long range gun are made use of. One of these is stationary and is used as a reference sight. The other is mounted upon the movable head of the concentrator frame which can be swung in a wide arc. These

Photo courtesy RKO Radio Pictures Studios

Fig. 3. A double concentrator pickup covering a wide angle of action. Note the mike man in foreground sighting his concentrator through center peephole.

sights afford a means of quickly lining up the concentrator in the lateral plane, with reference to the pickup source. The concentrator bowl is also adjustable in a vertical direction through a cam lever arrangement. A peep hole is provided in the approximate centre of the bowl through which the mike man sights on the speaker, tilting the bowl up or down as required so as to just cover the action with the beam. It is somewhat ambiguous to speak of focusing these devices upon the source of sound, since they cannot strictly be considered to have a definite focal depth, certainly not in the degree that obtains with photographic lenses. Pickup is not limited to one certain distance within their beam, with sound originating ahead of or behind this distance being blurred out. With a true ellipsoid reflector, having two conjugate foci, it would be possible to focus sharply upon the source of sound at a definite distance, excluding other sounds from the pickup. This would require two reflecting surfaces of ellipsoidal shape. Sound occurring at a certain distance with reference to one of these would then be reflected back to an opposite point of focus equi-distant from the second reflector, the distance between the two surfaces being determined by the dimensions, angles of curvature, etc., of the reflectors.

Fig. 4 illustrates the theory of pickup with such a device. Naturally it is impossible to construct a movie set in an ellipsoidal form (to afford the opposite half of the reflector) and still obtain satisfactory photographic results. Accordingly, it is only possible in practice to realize a partial ellipsoid, the main effect of which is to soften the focus preventing undue emphasis on the treble range. Some degree of discrimination probably does obtain against sounds originating at a distance considerably removed from that for which the reflectors are theoretically designed. Both types of concentrators may be made to discriminate further against undesirable background sound by tilting their planes as sharply downward as possible, thus limiting the angle of pickup.

It is general practice when utilizing these devices for pickup to shoot close-up quality of sound only, modifying the quality in re-recording when necessary to stimulate more distant pickup for the long shot picture. It is also possible, however, to utilize a combined concentrator and open microphone pickup, to secure close-up and long shot perspective at the same time at an additional saving in production time. Such an arrangement requires the use of two separate recording channels, of course.

The use of microphone concentrators in sound pickup work is in a broad sense a recent development. Early day broadcast engineers used a common wooden chopping bowl to intensify the pickup of the quite insensitive microphones then available. A patent covering the use of parabolic reflectors in broadcast work was applied for in 1924 by C. W. Horn, then superintendent of radio operations of the Westinghouse Electric and Manufacturing Company, a patent being granted in October, 1929. The application of such devices to sound picture recording, however, has until recently been neglected. Experimental work carried out by staff engineers under the direction of Carl Dreher, director of sound at RKO Radio Pictures Studios in Hollywood, at once demonstrated their value in this new field. They have now been in use for nearly a year, and while by no means considered as a panacea for all problems of pickup encountered, they constitute a very interesting step in the right direction. By the judicious use of such devices in combination with open microphone pickup, a considerable increase in speed of production and facility in photographing is effected; in some cases a reduction in overall production cost as high as 15 per cent has been obtained. This is an important saving when one considers the cost of large outdoor types of productions. The use of concentrators also makes possible the recording of difficult outdoor shots which might otherwise have to be sacrificed. Coupled with the added flexibility of movement permitted the actors, which the extended area of pickup affords, it does not seem too optimistic therefore to assert that the introduction of these microphone concentrators in motion picture work marks one of the most important developments since the inception of sound picture recording.

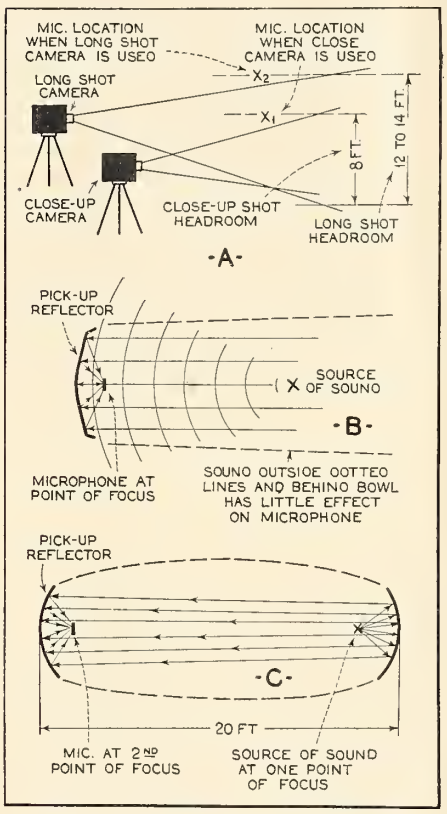

Fig. 4.—A. Showing how combined long shot and close-up camera set-up affects relative placement of microphone with regard to action. B. Pickup with portable concentrator. C. Theoretical assumption of reflection using ellipsoid reflectors. Such a reflection has two focal points, equidistant from either reflector. Sound originating at any other point is not sharply focused on concentrated back reflector (set walls, etc.).

In addition to a paper on the subject, "Microphone Concentrator in Picture Production," delivered by Mr. Dreher at the October, 1930 convention of the Society of Motion Picture Engineers in New York, and which appears in the January, 1931, issue of the Society's Journal, the writer is indebted to Ralph K. Spotts and Philip J. Faulkner, Jr., RKO Radio Pictures' technical staff, for much of the information on these devices contained herein.

▲

SELSYN MOTORS FOR SYNCHRONOUS SYSTEMS

SELSYN is the name of a make of self-synchronous motor. These motors are similar to three-phase induction motors, but have shuttle wound rotors with definite poles, the windings of which are connected through collector rings to a single-phase, alternating-current source of excitation. Two of these motors are used in a Selsyn system, one operated at the sending point as generator, and called the transmitter, and the other at the receiving point as a motor, and called the indicator. The stator windings of the transmitter are connected to those of the indicator. When the rotor-excitation circuit is closed, an alternating current voltage is impressed on the rotors of both the transmitter and the indicator. Since the indicator rotor is free to turn, it assumes a position similar to that of the transmitter rotor, as the transmitter rotor is turned, the indicator rotor follows at the same speed and in the same direction. It will thus be seen that as the transmitter rotor is moved, whether mechanically by gears or a float in a liquid, or manually for signaling or control operation, the indicator immediately follows and assumes the desired position. A pointer attached to the rotor shaft will then indicate exactly as at the transmitter, and further for continuous indicating this motion can be transmitted to a recording instrument.

Testing Equipment for Sound Projection

By E. W. D'Arcy*

CONSIDERABLE interest has been evidenced by the sound industry in a practical means of locating trouble quickly with a minimum loss of time.

A tester has been designed for this purpose, making possible a complete checking of theatre sound systems rapidly and with unfailing accuracy.

Incorporated in this equipment are facilities to measure vacuum tube characteristics, continuity of circuits, photoelectric cell operation, phasing of loudspeakers where multi-speaker installations are made, and testing the frequency response characteristics of the entire sound system. A great deal of attention has been paid, in the design of the equipment, to the conditions encountered when used with various types of theatre equipment. As will readily be realized the establishment of known standards of performance when testing the same kind of equipment repeatedly is rather easy, but where application of a tester is used in the field with several types of equipment, facilities must be incorporated within to allow reliable data to be itemized quickly. The detailed description of the test facilities incorporated in this instrument will undoubtedly be highly informative to individuals and firms with testing problems.

Vacuum Tube Characteristics

This tester, being primarily a piece of field equipment, uses the power supply furnished by the sound installation for measurements of vacuum tube characteristics. Plugs are used to obtain power for tube measurement direct from the socket in which the type of tube to be measured is operated normally. Adapters are supplied, allowing measurements of any type of tube.

Continuity of Circuits

For testing circuit continuity, the master selector switch is set for the continuity test. When in this position, a direct short circuit will give a meter deflection of four and one-half volts. This provides a speedy means of test setup for checking circuits for opens or shorts.

Photoelectric Cell Operation

The accurate determination of photoelectric cell and associated optical system performance can best be determined by tests made with the equipment in normal operation. It is understood that different values of exciter lamp brilliancy are used with various makes of projection equipment. The establishment, therefore, of previously determined photoelectric cell current is somewhat complicated by reason of this variance in operational characteristics.

Successful operation of any sound device using a slit and photoelectric cell is dependent upon variance of light intensity above and below a previously determined light standard, this variation in normal operation being supplied by the sound track on the film. A photoelectric cell operating properly does not depend for its successful operation on any one specific light value, but rather upon light variation, for its performance. In this respect a photoelectric cell is somewhat similar to a vacuum tube, illumination being considered as the variable grid potential. To carry the analogy a little further, possibly a better way of grading photoelectric cells would be in a term corresponding to the mutual conductance of the vacuum tube.

Determination of photoelectric cell performance can best be made, due to the factors previously mentioned, if a standard light source is used and the light reaching the photoelectric cell from this source varied in its value in a normal manner by, for instance, the insertion of test film whose development and exposure have been accurately determined. An innovation is, therefore, presented in modes of testing by the use of film which has been exposed to four different known light intensities and, when measurement of photoelectric cell current is made with this film, the result is directly transposable into decibels which accurately determine the performance of the sound track system under test.

In operation, the microammeter supplied with this instrument is connected in series with the photoelectric cell and exciting power supplied. Measurements may then be made of the current flowing through the cell with different values of light as supplied from the light source through the standard film. This information is then plotted on standard graph paper. The results are then compared with the characteristics plotted by the manufacturer of the photoelectric cell. The procedure seems rather difficult, but is really no more so than that of testing a vacuum tube wherein the grid voltage (the amount of light varied and determination of tube excellence obtained by the noted corresponding variation of plate current) which compares with photoelectric cell current variance. It is fairly obvious from the foregoing statement that the unmodulated current of a photoelectric cell is not an accurate way of determining whether a photoelectric cell is defective or not. This test procedure, when applied to equip-

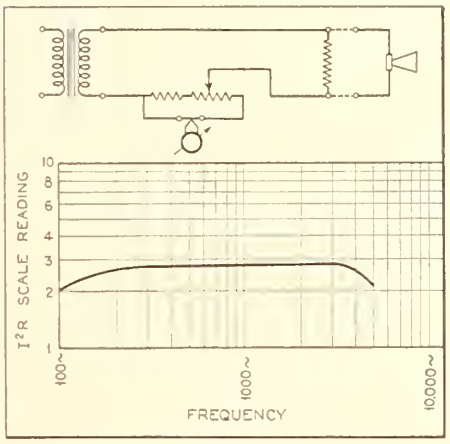

Fig. 1. Response curve, theatre amplifier.

* *Chief Engineer, D'Arcy Labs.*

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Description of What May be Accomplished in Projection and Recording by Testing and Checking Electrical Equipment

ment in operation, allows speedy determination of defects in the optical and photoelectric cell systems.

Phasing of Loudspeakers

Unless all of the speakers in multi-speaker sound installations are so connected as to be in phase, difficulty in sound distribution will be encountered. The test procedure for checking this condition speedily is quite simple, it merely being necessary to connect a source of direct-control to the voice coils of the speakers and note the direction of movement of the voice coil. As an example, all coils should move forward simultaneously upon application of a direct-current, dependent upon the polarity of current.

Frequency Response Measurements

It is often desirable to determine with reasonable accuracy the frequency response characteristics of the amplifier system from the pickup device to a known terminating load. A thermo-

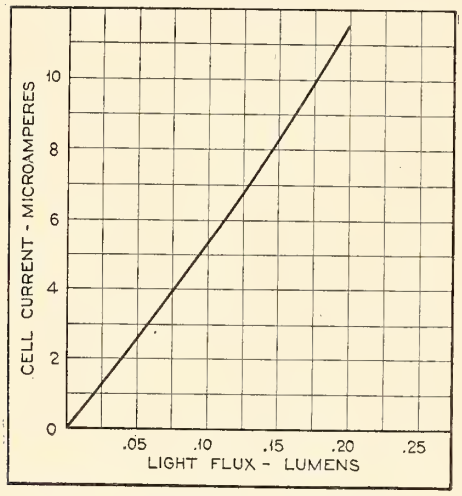

Fig. 2. Photoelectric cell characteristics.

galvanometer with a multiplier is supplied for this purpose.

Standard test procedure for these measurements is given herein. Resistance units of the correct value to replace the existing speaker bank are connected across the output of the amplifier under test. The output terminals on the testing panel are connected in series with this resistor bank. Frequency test records or film is then set for a standard frequency of, say, 1,000 cycles. The multiplier supplied with this device is then so adjusted as to bring the meter deflection on the thermogalvanometer to a previously determined center scale reading. Logarithmic cross-section paper is used in plotting the graph. Since the readings are taken from a thermocouple galvanometer and then plotted on log paper, the curve will be immediately translatable into decibel units. A curve made on a representative amplifier is shown, Fig. 1, to illustrate the ease

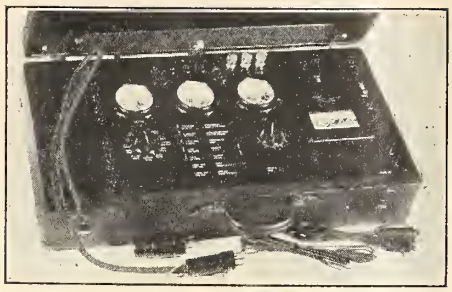

Fig. 3. A typical test set for sound circuits.

with which the graph may be plotted.

It is highly desirable, in making these tests, that the speaker bank be replaced by non-inductive resistors of known value. It is suggested that the replacement resistances be matched to the impedance of the speakers at 100 cycles.

More accurate determination of the frequency response of an amplifier can be had if an oscillator be used in place of the pickup device. It is then merely necessary to hold the input to the amplifier at a uniform level and make notations of the variations in current as shown by the thermogalvanometer.

Testing Versatility

Any piece of testing apparatus must of necessity be versatile and facilities incorporated to allow any component part to be used individually in cases where the necessity arises for such use.

A suitable instrument is exceedingly versatile in that respect as each meter is equipped with multipliers which permit a wide extension of their range of measurement.

It is possible, with this equipment, to measure input and output voltages of the power supply transformer as well as current flowing through any part of the circuit. The continuity test can also be used for the measurement of resistance as a calibration is supplied with each tester, showing the resistance per unit scale of variation occurring in the voltmeter.

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TALKING PICTURES IN SCHOOLS

HARRY D. KITSON, of Columbia University, New York, thus summarizes the present value of modern sound projection to education in schools:

(1) It will prove a useful supplement alike to textbook and to teacher.

It will not wholly take the place of either. It can, however, bring the textbook to life, and it can relieve the teacher from the merchandising of information, leaving his energies free for the higher role of guide in the learning process and giving him more time for attention to individual pupils.

(2) It will improve the quality of instruction.

At every point where the talking film proves at all usable, it can present instruction by the masters instead of by the mediocre upon which we must all too often lean.

(3) It will make possible frequent repetition of materials, where desirable, without consuming the teacher's time for such repetition, and insuring that the repetition shall be exactly the same.

(4) It will make possible a widening of the curriculum that might not be possible if teachers had to be hired and expensive equipment bought.

(5) It will enable pupils to learn through the eye as well as through the ear—two senses that are not always adequately employed in learning.

(6) It will enable us to standardize the content and quality of all instruction that should be standardized throughout a State or Nation.

(7) It will make possible many economies.

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R-K-O GETS PATHE EXCHANGE

CONSUMMATION of the sale of assets of Pathe Exchange, Inc., to Radio-Keith-Orpheum Corporation was announced on February 2, by Hiram S. Brown, president of the latter company.

The deal previously was approved by a majority of Pathe stockholders, but various suits had been brought to halt the transfer. These legal actions, it is reported, were withdrawn following a long conference on February 1.

Pathe Exchange, Inc., retains its 49 per cent. interest in Du Pont Pathe Film Manufacturing Company, but sells its studios and other principal assets to R-K-O for $4,630,789, payable in notes maturing over a period of about five years.

Mr. Brown issued the following statement concerning plans for operation of Pathe properties:

"It is intended to operate two distinct and separate motion picture producing and distributing organizations—one the present R-K-O Radio Pictures Corporation and the other a separate company to continue the operations of the present Pathe studio and Pathe branch offices in this country and abroad.

"A separate production organization will be maintained in the Pathe studio in Culver City, Cal., which will function independently of the Radio Pictures studio.

"In the sale and distribution of Pathe pictures the present Pathe branch offices, manned by the Pathe personnel, will continue to function as a separate selling and distributing organization. There will be an independent home office for the new company in New York city at its present headquarters on Forty-fifth street. While the full name of the new operating company has not been definitely determined, the word Pathe will be maintained in its corporate title."

The taking of a well remembered scene in "All Quiet on the Western Front"

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The Camera Crane

Used in Making Intricate Shots

By Gordon S. Mitchell*

WHENEVER an especially involved camera shot is desired, the great camera crane is called into service. This crane can, in the language of its operator, "do anything but talk."

The crane itself is electrically operated, controlled by the operator who rides in the cage on the end of the boom at all times. Large electric motors, properly geared, enable the crane to be moved up and down, forward and back, and from side to side, at any speed. Mounted as it is upon rubber tired wheels, the entire assembly may be made to crawl forward or back at the same time that the crane proper is moving in any other direction. The cage may be placed at any point within a sphere whose center is at the base of the boom and of a radius of approximately sixty feet. The cage may be set down upon the floor or stationed sixty feet in the air, straight overhead. As may be seen in the photograph, the cage floor remains level in any position. Due to the extreme versatility of the crane, it is possible to achieve any desired camera effect.

A Dramatic Episode in "All Quiet"

The crane was used extensively during the filming of Universal's "All Quiet on the Western Front," from which the scene herewith presented is taken. Many of the particularly striking photographic effects in this picture were shot with the aid of this crane. Being built and mounted as it is, the crane may be taken inside of any sound stage for interiors, or to any location for exteriors. An impressive shot, which was much enhanced by the use of the crane, comes to mind. The setting was a diplomatic ball—with all of the pomp and splendor usually associated with such affairs. The orchestra played at the far end of the room, from their place on a platform raised a foot or so above the general floor level. Hundreds of dancers, the men in brilliantly decorated uniforms and the ladies in long evening gowns, filled the hall. While the director wished to lose none of the brilliance and color of the background, he also wished to pick up and fasten attention upon his main characters, in order to carry the action and plot along.

A Difficult Set

The set was probably two hundred feet in length and sixty or seventy feet wide. A wall, with offset boxes in which sat the dowagers and their escorts, ran the length of one side. The star and his lady were to slowly walk along the edge of the dance floor, close to the wall below the boxes. While there are several ways in which this shot could be obtained, the crane presented the simplest solution to the problem. It might have been taken by mounting the camera above, and from a stationary position following the action with the lens, or the camera

* *Sound department Universal Pictures Corp.*

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Ingenuity Provides Photographing and Sound Recording Device for use in Difficult Positions

might have been mounted upon a small perambulator which could have been rolled along among the dancers immediately in front of the principal characters.

This last type of shot, in which the action follows the camera which moves about the set always focused upon that action, is very common in motion picture photography. However, by using the crane a commonplace piece of photography was turned into an impressive and extraordinary example of the camera-man's art. The crane was tracked along the far side of the set, the boom arm reaching out over the heads of the dancers. The cage immediately preceded the principal characters, placed so that the camera shot at an angle down upon them. Keeping pace with them throughout their walk along the dance floor, attention was focused upon them until they reached the end of the hall, at which spot the crane began to rise, and from a height of forty-five feet, the camera in one grand sweep took in the entire colorful scene. Such photography, interspersed throughout the more commonplace scenes, does much to determine the success or failure of any motion picture. The problem of keeping the plot moving along and at the same time impressing the beauty and color of setting upon the spectator is solved in many instances by the camera crane.

Camera Mounting

The camera is mounted upon a regular tripod set upon the floor of the cage, and the microphone may or may not accompany the camera upon the crane depending upon the type of shot desired. The cables, which in the accompanying picture may be seen entering the cage through the hub of the large wheel, are power lines which carry the current for the camera motors. The smaller cable at the floor level is the microphone cable, which connects the mike to the sound recorder. A cue box, which enables the operator to be kept in contact with the director is mounted in front of the assistant's post at the left. Various colored lights, one of which means "up," another "down," another "forward," and so forth, each separately controlled from a switch in this cue box keep the operator informed at all times as to what type of motion the director desires.

This cue box is made necessary due to the need for absolute quiet while actual photography is going on. All of the director's commands must be made noiselessly. The large hooded object on the cage is the camera, so covered in order that camera noise will not be picked up by the microphone, seen directly over the players in the illustration.

This crane is only one of the many mechanical devices which have been developed in the studio shops to add to the spectacular quality of present-day motion pictures.

Study Conducted on Use of Films for Advertising

EXPLOITATION of the motion picture by American industry, now rapidly reaching into the field of advertising films for theatre exhibition, is being surveyed by the Department of Commerce, according to an oral statement January 6 by Eugene I. Way, of the Motion Picture Division, in charge of the survey.

The Department's survey will seek to determine the many uses to which the motion picture is being put in business and the value attending its employment. The incorporation of sound in the industrial film will be investigated and this phase of motion picture development may be the object of a separate study following the general survey, he stated.

Films Widely Used

The use of the motion picture in business has been established for some time, Mr. Way explained, and today its services extend into practically every channel of trade. It is being employed by almost every large manufacturing concern and by many merchandising establishments and its uses range from factory operation instruction to sales promotion demonstrations. The development of this field of motion pictures, he said, has stimulated the establishment of numerous independent industrial film companies which produce for this market and has attracted the attention of the big feature studios, some of which are entering the field.

In conjunction with the expansion of the industrial film used for interorganization purposes, the business motion picture is now being advanced for theatre exhibition. This development, Mr. Way explained, is being promoted on the assumption that "romance in industry," affords a rich field for motion picture exploitation, especially now that sound has been incorporated into the film. This type of film is being produced for theatre presentation by large picture producers at the instance of business organizations. Recently, one such film, employing a well known comedian, was produced for a large insurance company which plans to distribute the film in various theatres. These films follow two general trends; those which are shown "by courtesy of" the advertiser and have no direct advertising in the run of the film, and those which embody advertising in the film proper. The "courtesy" films are analogous to radio programs presented by business firms which are without reference to the company during the course of the entertainment, it was explained.

According to the division's information, Mr. Way said, there are approximately 5,000 theatres, with a seating capacity of 18,000,000 persons, which have been made available for the distribution of entertainment films distributed by business concerns. Efforts are being made to enlist additional theatres as outlets for these films, he said.

The activities of industry in this field of motion pictures will be included in the division's survey of business pictures, the questionnaire sent out for the survey listing inquiries on the various uses of films in industry by those concerns which have included motion pictures in their advertising expenditures. A statement by the Department regarding the survey follows in full text:

To what extent the American movie has "gone into business" as an aid in promoting operating efficiency, and the degree of success attending the use of such methods by industry, form the subject of a special study now being made by the Motion Picture Division of the Bureau of Foreign and Domestic Commerce.

At least 2,000 concerns in the United States, it is known, have used the motion picture for some business purpose. In other cases the ends sought are creation of good will through illustration

(*Concluded on page 22*)

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Commerce Department Expects to Determine Results Obtained from Business Pictures

Radiovision Programs in the Making

By Austin C. Lescarboura
Mem. I.R.E. Mem. A.I.E.E.

In Which We Study the Program Possibilities of Radio Television Broadcasters in Creating Public Acceptance

THE American public is ever ready to invest in sound entertainment. Be it theatre, movies, talkies, circus, broadcasting and even television, the average family will dig down into its pocket and salvage enough loose change to pay for that which makes it forget its troubles and cares. And thereby hangs the following discussion of just what can be done by radiovision workers in gaining public acceptance for the radio television idea preliminary to building up a large and profitable industry.

Until now, the greater part of television broadcasting has been of an experimental nature. In fact, the television broadcasters have made no special attempt to interest the average layman beyond the mere curiosity stage. Television broadcasters have been experimenters first of all, and showmen last of all. Most transmitters have been of a haywire nature, subject to changes every fifteen minutes by the clock. If television has been made the joke of hard-boiled journalists, it is because of changes in the usual equipment on the very eve of an important broadcast demonstration, resulting in a grand flop to the disgust of all concerned. Until now, television experimentation and television entertainment have been wrapped in a single package, with the same facilities used in catering to the extremes of experimenter and layman.

To those closely identified with radiovision development, it has been a source of consternation to note how slowly radiovision equipment has sold to the public at large. Even before the Wall Street crash, which is as convenient an alibi for television's slow progress as it is for any other line, the public did not rush in to buy a complete radiovision receiver for a mere $400 list. That $200 list is as much as the public will spend for something that is certain to become obsolete in a year, and that the public insists on tuning in to something worth seeing on definite schedule, are points heretofore not mentioned in reports to the Board of Directors or to others interested in radiovision's welfare.

Reasonable Progress Made

From an engineering standpoint, radiovision has made rapid and satisfactory progress during the past six months. Today it is possible to transmit and to receive scenes with as many as half a dozen persons, and with some background. Standard motion picture film may be broadcast, although all scenes are not equally suitable for this purpose. It is possible to broadcast excellent closeups of living persons. With silhouettes, fair entertainment possibilities are now at hand. And of course, the synchronized sound accompaniment greatly enhances the radiovision presentation. Indeed, almost unlimited entertainment value is available if sound accompaniment is employed.

Just now, the engineers engaged in radiovision work may well rest on their laurels for a few moments and allow the merchandising brains to catch up with them. The engineers have given us a practical experiment. It now remains for merchandisers to convert that practical experiment into a self-supporting and even profitable industry.

Just what can be done to make radiovision interesting to the average American family? That question is now in order, and here is our answer based on recent observations.

There are four forms of radiovision presentation available today, with the existing engineering status of the art: (1) the film pickup, with or without sound accompaniment; (2) the flying spot pickup for personality close-ups, with or without sound accompaniment; (3) the camera pickup in the studio, with or without sound accompaniment; and (4) the outdoor camera pickup in conjunction with the portable transmitter, with or without sound accompaniment. Analyzing these in due turn, here is what we have by way of an entertainment inventory:

The film pickup is the favorite with most radiovision broadcasters, for the reason that heretofore this method has provided the least troublesome program. It has been unnecessary to have persons stand and act before the radiovision pickup. Instead, the same film has been ground through the pickup, hour after hour, until much of it has gained the appearance of a scene taken during the Deluge, due to the "rain" on the wornout film.

Until quite recently, the usual 48-line or 60-line scanning system has not permitted of really fine detail. In fact, C. Francis Jenkins, a pioneer radiovision broadcaster, made all his films until recently, in silhouette or black-and-white form. Within the past three months, however, radiovision workers such as the Jenkins Television Corporation and the DeForest Radio Company, have found it entirely feasible to handle standard motion picture films, including backgrounds and several persons.

Film Pickup

Just as the automatic piano and the phonograph played a major role in early sound broadcasting, so must the film pickup serve as the backbone of

Side view of Jenkins television camera with amplifier case opened to show tubes.

The television cameraman focusing and checking up on his pickup by means of the monitoring view-finder.

the radiovision program. It is bound to work hour after hour in supporting a daily schedule, but this is no reason why it should not prove attractive to the lookers-in. To this end, some of our more advanced broadcasters have arranged for regular film rentals so as to have a steady supply of fresh film. The only point which we hope they will observe in presenting such film is to preview each film under typical radiovision conditions, editing the film accordingly so as to present over the air only those scenes which are really meaningful. Too often an otherwise convincing demonstration of radiovision entertainment is ruined by including a moonlight scene or an out-of-focus scene which means little or nothing to the chap a hundred miles away, peering anxiously into the radiovisor and wondering why his results have suddenly gone haywire.

Sound Accompaniment

Sound accompaniment is invaluable to radiovision entertainment at the present stage of the art. Some of the broadcasters are equipped with combination film and disc pickups, so that sound-on-disc films may be employed, although such films must be made to order since television pictures are run at 15 pictures per second instead of the higher speeds for theatre work. For this reason too the sound-on-film subjects are not suitable today, although the radio television engineers are working out a means of utilizing standard sound films.

The sound accompaniment is, of course, handled through a second radio channel. Several radio television stations have suitable tieups with sound broadcast stations, so as to provide a sound accompaniment. It is well to note that the sound accompaniment may be on the usual broadcast frequencies, thus being tuned in by the usual broadcast receiver, or slightly below the usual broadcast frequencies but still tuned in by the average broadcast receiver at its lowest dial setting. Again, the sound accompaniment may be on a short-wave frequency. Also, the sound accompaniment may be nothing more than the standard broadcast entertainment feature as now presented, with radiovision as an optional feature. Some programs have already gone on the air in this manner, with the announcer stating that a radiovision presentation of the program was available on such-and-such a wavelength for those provided with the necessary equipment. Indeed, it is our personal belief that radiovision will fit in best by being a supplement to the usual and established broadcast features, purely as an optional consideration, rather than as a prime entertainment factor, for a long while to come. It is simple enough to include a radiovision pickup in the broadcasting studio, so as to have this optional feature. Or it may be possible to have a film pickup handling some suitable visual accompaniment to the musical program. Let us make no mistake aoout it, the aural entertainment will always be more interesting to the public than the visual. It should, therefore, be the main feature at all times.

Flying Spot Pickup

The flying spot pickup has made notable progress in the past few months. Prior to this period of rapid development, this technique consisted of a tiny spot of light flashed line by line horizontally across the subject pressed up against a frame carrying photoelectric cells, behind which was the revolving disc and light source. Recently, the engineers have evolved ingenious photoelectric cell units, comprising cell, reflector and amplifier, mounted in suitable camera-like units on fully adjustable stands. Thus the photoelectric cells may be placed at any distance and any angle with relation to the subject, obtaining the reflected light from any angle, thereby obtaining interesting lighting effects not unlike those with photography. The flying spot is an ideal pickup means for personalities, but unless the microphone for the sound accompaniment is at hand, the entertainment possibilities are of a very low order. Just merely to watch a person speak without hearing what that person says, or to watch a musician play without hearing anything, is decidedly dull. After the first thrill of seeing a picture flashed through space, there is little left to do but to yawn and fall asleep.

Camera Pickup

The camera pickup takes the subjects out of the darkened room, made necessary by the flying spot technique, and into the fully illuminated studio or even outdoors. Recently some really practical radiovision cameras have been developed, with interesting features and possibilities. The usual camera comprises an exceedingly fast lens, an enclosed scanning disc, a photoelectric cell, and an amplifier, suitably housed. One of the latest cameras includes a direction finder and focusing feature whereby the operator sees in televised form precisely what he is picking up. This feature is really a visual monitoring check on what is being sent over the line to the transmitter. The operator usually wears a pair of headphones, so as to be sure of his signals by the characteristic sounds while the camera is in operation.

The beauty of the camera pickup is that larger groups can be handled than in the case of the flying spot, and also that the actors have full freedom of action within the field of the camera lens. Greater amplification is neces-

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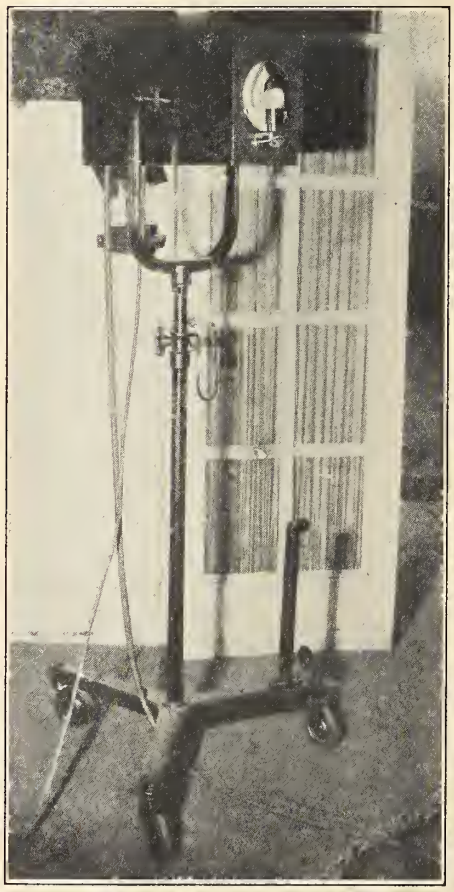

Adjustable photoelectric cell unit employed for direct flying spot pickup.

Amplification in Sound Motion Picture Work

Part I

By Charles Felstead*

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The Projectionist and the Engineer Will Find Here a Detailed Description of the Equipment in Present-Day Sound Amplifying Systems

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A SOUND recording channel for motion picture work can be roughly divided into three main departments; pickup and monitoring, amplifying, and recording. There are, of course, a number of other departments in the sound recording studio which are more or less intimately connected with these three departments that are directly associated with the actual recording work. By a curious analogy, a sound recording channel can be compared to a human being—the microphone being the ears of the sound system, the monitor man and his controls representing the brain, the main amplifying equipment being the heart that supplies the energy to the recording system, and the hands the recording device that makes a permanent record on a suitable sensitive medium of the sounds picked up by the microphones. A thorough discussion of the monitoring equipment and of the art of monitoring, and some description of the pickup equipment, or microphones, was contained in the series of articles on monitoring that has been appearing in Projection Engineering.

Reviewing briefly the material leading up to this article, we see that a sound originating within range of a condenser microphone in the sound stage sets up a series of condensations and rarefactions in the air, which strike the diaphragm of the microphone, causing it to vibrate in tune to the frequency of vibration of the sound source. This movement of the microphone diaphragm, which forms one plate of a small condenser, produces a minute alternating voltage on the grid of the vacuum tube in the amplifier that forms a part of the microphone. This alternating voltage likewise has a frequency that corresponds exactly with the frequency of the sound. This minute voltage is amplified by the one- or two-tube amplifier mounted within the microphone assembly, and then transmitted along the microphone cable and line to the monitoring apparatus in the monitor room. There, each microphone is connected to a special potentiometer on the mixer control panel, which permits the proportionate amount of energy fed to the recording system by the individual microphones to be regulated. The speech current is at a very low electrical level in this part of the recording circuit, and it is necessary that it be amplified to a suitable value by a two- or three-stage "booster" amplifier. The output of the amplifier connects to another special potentiometer which is for the purpose of controlling the overall amount of sound current that is delivered to the main recording amplifiers from the several microphones. The output of this potentiometer is

LEGEND FOR DIAGRAMS

E_1 = grid voltage (the C battery)
E_2 = filament voltage (the A battery)
E_3 = plate voltage (the B battery)
G = grid of tube
F = filament of tube
P = plate of tube
R_p = plate resistance
I_p = plate impedance
CC = coupling condenser
GL = grid leak
V_1 = first amplifier tube
V_2 = second amplifier tube
P′ = primary of coupling transformer
S′ = secondary of coupling transformer

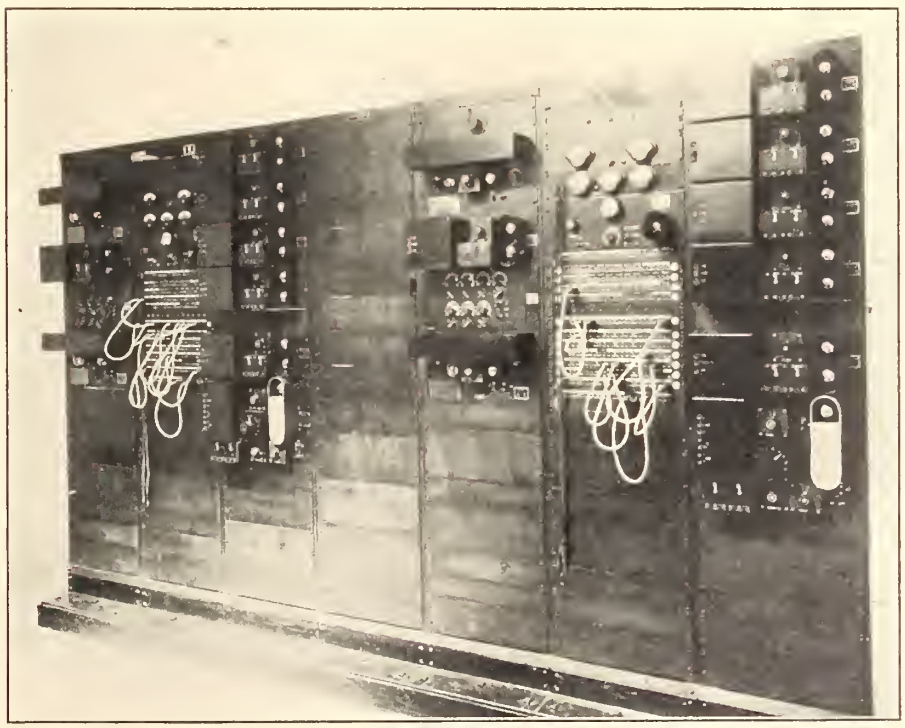

Fig. 1. Amplifier bays of two-channel recording installation.

* *Sound Engineer, Universal Pictures Corp.*

carried by a transmission line to the main amplifiers in the amplifier roof. It is at that point that the discussion in this article begins.

Amplifier Bays

In the accompanying photograph, Fig. 1, may be seen the amplifier bays of a two-channel installation of the Western Electric sound recording system. A channel includes all of the equipment that is directly connected with a single recording unit, from the microphones on the stage to the two or four recording machines in the recording room. There must be a separate channel for each sound stage that is in operation at any one time, although the recording channels are arranged so that they can be switched from one stage to another at will. Separate crews of men are required for each channel, the man in charge of the amplifying equipment being the only one who can double up in his work. The several permanent recording channels in a studio are installed in a building called the sound studio, which adjoins the sound stages. The main amplifying equipment for all the channels is situated in the amplifier room, which is generally located near the center of the sound studio. The main distributing frame, or MDF, at which most of the wires in the installation are brought to connection blocks and strapped together, and the switchboards carrying the switches for charging and discharging the batteries that supply power to the amplifiers are also located in this room.

As may be seen in the photograph, the amplifiers are mounted in vertical frameworks, which are called "bays;" and there are seven of these bays in a two-channel recording installation. Three bays are required for each channel, and the seventh bay—the center one—carries the jacks that are used

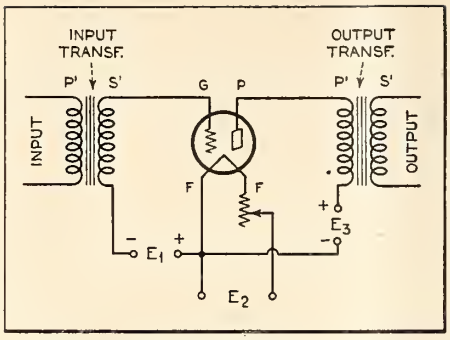

Fig. 2. Transformer coupled vacuum tube circuits.

for swinging the recording channels to different sound stages. Of the three bays that constitute one channel, the left-hand bay carries the amplifiers for monitoring, the center bay is for the volume indicator and auxiliary equipment, and the right-hand bay carries the amplifiers employed in the direct recording circuit. The frameworks that form the support for the amplifiers are rectangular in shape and are constructed of steel I-beams. Each framework is approximately seven feet high and twenty inches wide. These are mounted on a special concrete and cork foundation that is separate from the rest of the floor, in order that heavy vibrations will not be so readily transmitted to the sensitive tubes in the amplifiers.

The Amplifiers

The amplifiers are built on iron panels nineteen inches wide, and have removable metal box covers on the back that serve as electrostatic shields and prevent dust from accumulating on the apparatus and in the wiring. The metal panels and covers are grounded through the framework. Blank iron panels are used to fill in the spaces between the amplifiers. Shielded leads connect the amplifiers to terminal blocks at the bottoms of each of the amplifier bays. Panels carrying fuses for all of the battery circuits in the amplifiers are also located at the rear of the bays. A heavy copper bar that serves as a common ground for all of the amplifiers runs across the bottoms of the seven bays in the installation. It is connected to a number of large copper plates that are buried in the earth directly beneath the amplifier room.

Before going into a description of the amplifiers and their arrangement in a sound recording installation, it might be well to examine in as concise a manner as possible the elementary principles of audio-frequency amplification and vacuum tube operation. An audio amplifier is a device for increasing the amplitude of any small alternating current having a frequency that falls within the audio-frequency band, which extends roughly from about twenty to twenty-thousand cycles a second. This small alternating current is applied to the primary of an audio transformer, or other suitable coupling device, the output of which is connected so that it produces a small alternating voltage between the grid and filament of a three-element (grid, filament, and plate) vacuum tube. The circuit of a simple form of transformer-coupled vacuum-tube amplifier may be seen in Fig. 2.

Now the characteristic of a vacuum tube when connected in this regular manner in an audio amplifier is such that a small change in the potential on the grid of the tube will produce a corresponding but larger change in the flow of current in the plate circuit. The grid of the tube is kept at a certain negative d-c. potential at all times by means of a C battery—or by bringing out a tap at a predetermined point in the filament circuit, thereby taking advantage of the voltage drop across a resistor in the negative lead of the filament. The alternating voltage applied to the grid in addition to this fixed negative voltage adds to the negative grid potential when the a-c. voltage is on the negative half of the cycle, and subtracts from the d-c. bias voltage when it is on the positive half of the cycle. Negative electrons are drawn from the heated filament in the tube to the plate by the positive plate potential furnished by the plate battery, and this flow of electrons to the plate constitutes the plate current. The plate current flow has a certain value when there is only the fixed d-c. bias voltage on the grid; but when an alternating voltage alternately adds to and subtracts from this steady voltage, the plate current is correspondingly decreased and increased.

The grid functions in a manner analogous to the action of a small valve that regulates the flow of a large

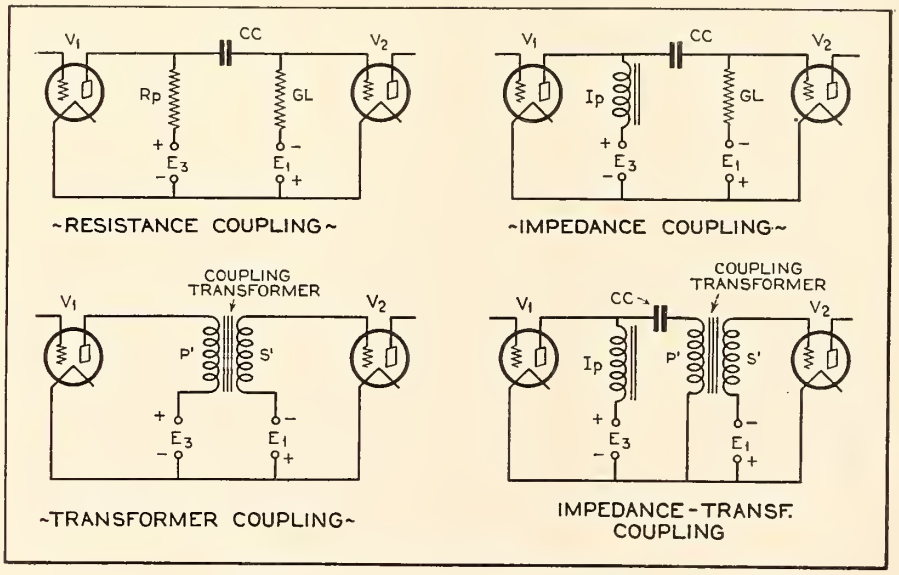

Fig. 3. Types of amplifier tube coupling.

volume of water. An increase in the negative potential on the grid reduces the flow of electrons from the filament to the plate, because the negative grid repels the negative electrons to a greater extent than it did when it was at a lower negative potential and will not permit so many of them to pass through it. For the same reason, a decrease in the negative potential of the grid in relation to the filament allows more electrons to pass, and so increases the plate current. So long as the tube is operated on the straight portion of its characteristic curve, the relationship between the grid voltage change and the plate current change will be a linear function. Otherwise, if it is operated on the toe or the knee of the curve, distortion in the output of the tube will be the result. The value of the fixed negative bias on the grid of the tube is the main factor in determining the portion of the characteristic curve on which the tube will operate. The operation of four-element and other types of tubes in audio amplifiers will not be described here because they are not used at the present time in sound recording work.

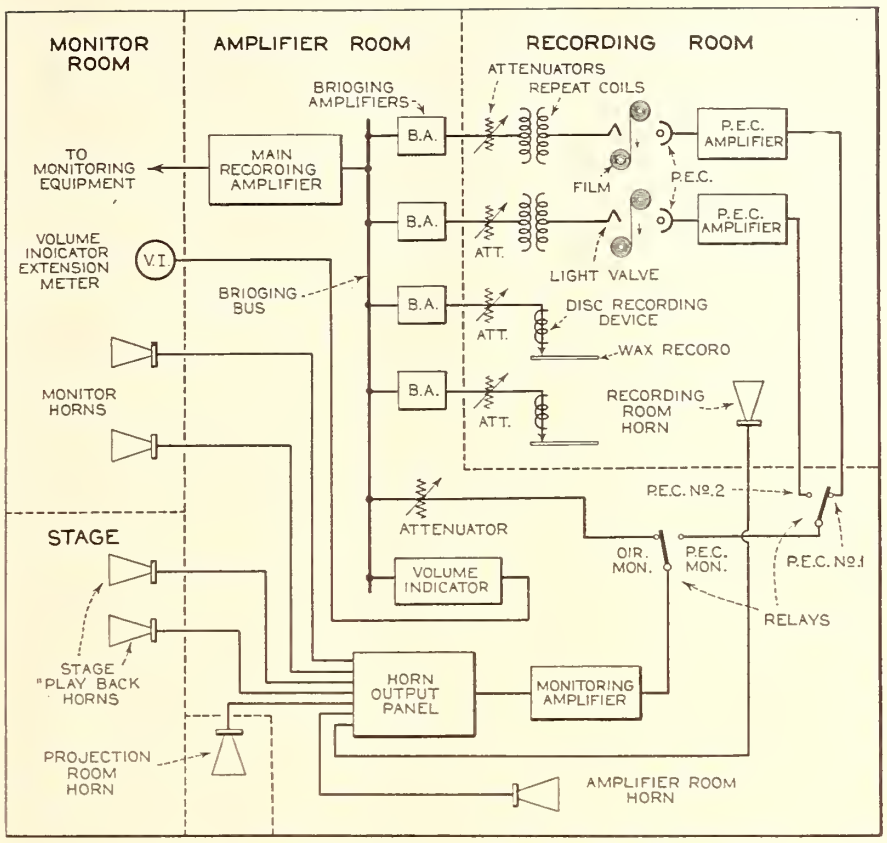

Fig. 4. Schematic of layout of a single recording channel.

Coupling Amplifiers Together

There are three commonly employed methods of coupling the output of an amplifier tube to the grid circuit of the next amplifier tube, or to the device that is to be supplied with power. These three types of amplifier coupling devices are known as resistance coupling, impedance coupling, and transformer coupling, and they are diagrammed in simplified form in Fig. 3. There is also an alternative form of transformer coupling, called impedance-transformer coupling, that is likewise shown. These types of tube couplings all act in more or less the same manner; but with proper design, transformer or impedance-transformer coupling provides a step-up ratio that gives greater overall amplification.

These coupling devices function in the following manner: The plate current flowing through the plate resistance, R_p, in the case of resistance-coupled amplification, produces a drop in voltage across the resistance. Any variation in the grid potential of tube V_1 causes a change in the plate current flowing through R_p, which results in a variation in the voltage drop across it. Actually, under average conditions, this change in the voltage drop across R_p is equal to the change in grid voltage multiplied by about two-thirds the mu (μ), or amplification constant, of the tube. That is, if the mu of the tube is nine, this voltage change in the grid circuit of tube V_2 will be approximately six times the voltage change in the grid circuit of tube V_1. The value of the plate resistance, R_p, in relation to the a-c. plate resistance of the tube—together with the μ—determines the amount of amplification that will be obtained.

As in the grid circuit, there are two current components in the plate circuit of a vacuum tube: the steady d-c. current component from the plate battery, E_b, and the a-c. current component that is produced by an a-c. voltage applied between the filament and grid of the tube. The a-c. current component in the plate circuit of V_1 is passed almost without hindrance by the coupling condenser, CC, to the grid circuit of tube V_2; but the direct current from the plate battery is effectually blocked by this condenser. Thus there are separate paths for the a-c. and d-c. current components to follow. In the resistance-coupled and impedance-coupled circuits shown in Fig. 3, the a-c. voltage on the grid of the second tube is higher than the a-c. voltage on the grid of the first tube, as was explained; but that is not due to the coupling devices, which have a one-to-one input to output ratio, the only amplification obtained being within the tubes themselves.

A transformer-coupled amplifier, however, provides an additional source of amplification in the coupling transformer used between the tubes. When properly designed, the transformer has a step-up ratio of primary to secondary that serves to increase the voltage change on the grid of the second tube, V_2, over the voltage change in the plate circuit of the first tube by a value depending on the step-up ratio of the transformer. With transformer coupling, less stages of amplification are needed to obtain the same amount of amplifier gain; but a transformer-coupled amplifier is liable to give a less uniform amplification at all audio frequencies than is an amplifier that uses either of the other two forms of tube coupling. Also, if the plate current flowing through the primary winding of the transformer is rather high and the transformer is poorly designed, the core will become saturated with the magnetic flux produced by the d-c. current and distorted amplification will be the result. To prevent that occurrence, impedance-transformer coupling, which provides separate paths for the a-c. and d-c. components, is commonly used in the amplifiers employed for sound recording.

This form of tube coupling is particularly desirable for these amplifiers because cores made of permalloy, or of similar core material of high permeability, are used in most of the transformers in them. The use of this core material provides an audio transformer having greatly improved characteristics; but there is the advantage that even a relatively small amount of direct current flowing through the primary of a permalloy-core transformer will ruin it for use in an amplifier. It is for that reason that impedance-transformer or resistance-

(*Continued on page 24*)

New Motion Picture Projection Optics

By W. B. Rayton*

The Addition of Sound Effects to the Moving Picture Called for Improved Light Projection Systems

THE improvements to be described were developed to meet the conditions which resulted from the addition of sound to the moving picture. Shortly after the installation of the earliest sound systems, complaints began to be heard as to the decrease in brightness of the projected picture. For two reasons this was not so high as these theatres had been getting from their old equipment. One of these reasons was the fact that it was found desirable to use a screen more transparent to sound than the old types of screen and this sound transparency was gained at the expense of the reflecting power of the screen. In the second place, in the sound-on-film processes, the picture area was restricted and required greater magnifications to restore the projected picture to the size which had become established for a given house. This increased magnification also resulted in a reduction in the brightness of the picture. The decrease was sufficient to be disturbing and from all the interested sources came a request for more illumination.

It is an important condition, also, that the advent of sound has stimulated interest in the apparatus and the technique of the projection room and simultaneously in the quality of the projected picture. Furthermore, the cost of sound equipment is so large that the question of a few dollars more for condensers and projection lenses does not look so formidable as it once did, Improved optical systems are the logical outcome of such conditions.

Work on both of these problems, projection lenses and condensers, has been under way in the scientific bureau of the Bausch and Lomb Optical Company for several years. Experimentally satisfactory results had been reached and plans were being made for production of these new optical systems when the wide film activities began. The experimental projection lenses developed were found to yield a quality of performance absolutely unapproachable by anything else available. The condenser lenses on which we had been working were modified in a manner to be described presently and they were found to provide by far the best illumination obtainable for these huge pictures. Later, the same condensers were tried for the projection of 35 mm. film and were found to exceed by from 50 to 100 per cent the illumination obtainable with the condensers in current use.

Anistigmat Lenses

The projection lenses are sold under the name Super-Cinephors. They are true anastigmats, the first anastigmatic projection lenses which have been offered the motion picture projectionist. Projection lenses hitherto offered have been either of the type developed by Petzval nearly a century ago for use as a portrait lens or of a type which amounts essentially to a telescope objective with an achromatic condenser mounted a short distance ahead of the film which functions simultaneously as part of the illuminating system and as part of the projection objective. Projection lenses of the latter class have no distinguishing class name but are sometimes referred to as lenses with a short back focus. Both of these types are characterized by more or less the same type of performance, viz., very sharp central definition and a very small field of view which can be called flat. The latter type suffers somewhat more than the Petzval this limitation as to field of view. Fig. 1 is a reproduction of curves showing the curvature of field and astigmatism of these three classes of lenses.

Some explanation may be necessary to make the significance of these curves apparent to those who have not had the opportunity for much study of geometrical optics. It is an unfortunate provision of nature that a single lens, applied to the task of forming an image, gives an image about as far from the quality wanted as could well be and still have it recognizable as an image. The ideal image is the true projection of the object spaces onto a plane, such a projection as might be constructed by drawing a single line from every point in the object space through a pinhole and continuing them until they intersect the desired plane of projection. The image formed by a lens differs from this ideal in many respects. In the case of the pinhole, the image is equally sharp no matter at what distance from it lies the plane of projection, for it is assumed to be so small that only a single ray of light from any one object point can pass through it. The lens, however, is of finite size and many rays from any one object point are received by the lens.

For perfect performance all these rays coming from any one object point should be re-united by the lens in another point on the desired plane of projection (the focal plane of the lens). It happens otherwise, however, as illustrated in Fig. 2. Here there is represented an object point O lying in the margin of the field. Instead of the lens forming a point image of O, it forms as the nearest approach to it an elliptical spot of light as O′. If we explore the cone of light in the neigh-

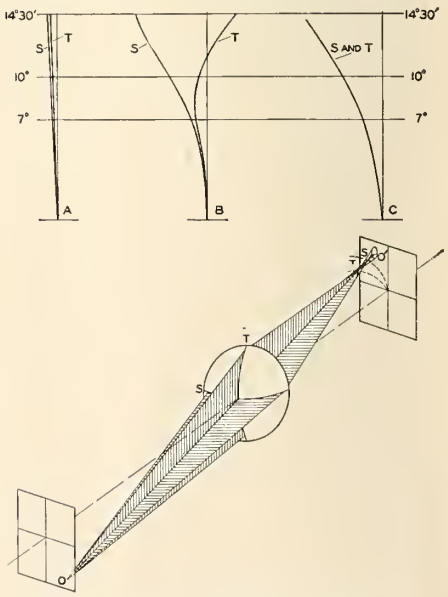

Fig. 1. (At top). Showing corrections for astigmatism and curvature of field for: A, Super Cinephor lens; B, Cinephor lens; C, Lens of short back focus. Fig. 2. (Below). Illustrating astigmatism and curvature of field.

*Director of the Scientific Bureau, Bausch and Lomb Optical Company.

borhood of O′, we will find that it nowhere comes to a point focus. At the place marked T in the diagram the light seems to be concentrated in a short line as indicated and at another place such as S it again seems to be concentrated into another line at right angles to the line at T. T is the focus for the meridian of the lens marked T, and S is the focus for the corresponding meridian of the lens.

The phenomenon of the representation by the lens of object point O as a pair of perpendicular lines is called astigmatism. The distance from O′ to the center of the distance between T and S is the curvature of field for the lens for this angle. The astigmatic difference (distance between T and S) and the curvature of field will vary from point to point over the field depending on the angle of the field of view. The focus of all points T and S is a pair of curved surfaces which constitutes the image of the object plane. These surfaces are indicated by the dotted curves connecting T and S in the figure with the center of the image.

Correction of Curvature

By using more than a single lens, compounding, diverging and converging elements and choosing glass and curvatures of surfaces to the best advantage it is possible to overcome or "correct" astigmatism and curvature of field. Different lens constructions lead to different degrees of correction.

Fig. 1 shows the condition of correction of astigmatism and curvature of field of the Super-Cinephor lens in comparison with two other types of projection lenses now in general use. The curves represent the positions of the focal points T and S with respect to the ideal focal plane (the straight vertical line) for fields of view up to 14½°. Lens B, the Cinephor is chosen as representing the Petzval type of lens. Lens C was bought on the open market as a representative of that class of lenses described above as characterized by a short back focus. It is peculiar in that the amount of astigmatism it exhibits is practically nil but such advantage as this would indicate is more than neutralized by the excessive curvature of field. While the T and S sections come to the same focus, that focus is farther from the image plane than either and considerably farther than the average of T and S in the Cinephor. The advantage of the latter over both the other lenses is manifest. The superior correction of the Cinephor with respect to astigmatism and curvature of field are the characteristics which entitle it to the rating of an anastigmat.

To add to the significance of the curves it is well to take into consideration that for standard film the angular field of view of a 5″ focus lens is about 14° and for a 4″ lens about 18°. For wide film the corresponding values are 23° and 29°. Since the curves in Fig. 1 are plotted for distance from the center of the field (half the total field) the above figures should be divided by two for reference to the curves.

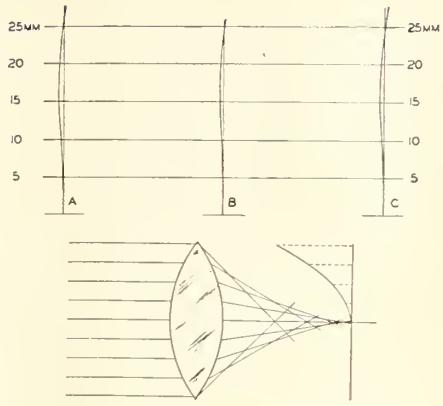

Fig. 3 (at top). Spherical aberration for: A. Super Cinephor lens; B, Cinephor lens; C, Lens of short back focus. Fig. 4 (below). Illustrating spherical aberration and a method of plotting it in curve form.

Sacrifice of Definition Avoided

The reason that anastigmats have not hitherto found favor for projection lies in the fact that for large relative apertures, the correction for astigmatism and curvature of field has been obtained at the sacrifice of definition in the center of the field. The construction used in the Super-Cinephor, however, permits central definition equal to that afforded by the prevailing types of lenses in addition to the excellent flatness of field. This is shown in Fig. 2 which contains curves representing the spherical aberration for the three types of lenses described above.

To comprehend the significance of spherical aberration it will suffice to consider briefly Fig. 4 in which is shown a bundle of rays of light coming from a distant object point at the left and falling on a simple lens. After passing through the lens they fail to unite in a common image point. All rays, however, which strike the lens equidistant from its axis; that is to say, in a zone of a given radius come to a common focus, but the focus for each zone differs from the focus for every other zone, the focal points for zones farther out from the center of the lens lying closer to the lens than the focus for the central zone. If we plot the radius of the zone on a vertical axis and the distance of the focus of the zone from the focus for the center of the lens on a horizontal axis and connect the corresponding points with a curve we arrive at a curve such as is shown at the right of Fig. 4 which is a complete representation of the condition of spherical aberration in the lens.

The result of spherical aberration in a lens is to prevent it from forming a sharp image of the object. The outlines of the details in the field will be blurred and black areas will be more or less gray instead of black. From Fig. 2 it will be evident at a glance that there is practically no difference between these three kinds of lenses in this respect and that the superior performance of the Super-Cinephor in respect of astigmatism and flatness of field has not been gained at the expense of image quality in the center of the field.

The quality of the performance of these lenses has never been equalled hitherto in projection lenses. It is a revelation to see the quality of performance given by a 2-inch focal length working at a speed of f:2, and covering standard motion picture film. The focal lengths from 3½ inches up will cover the 23 x 46 picture of wide film with complete satisfaction when employed with suitable condensers.

Super-Cinephors are made in focal lengths from 2 inches to 2¾ inches in the speed of f:2, and from 3 inches to 5½ inches in the speed of f:2.3. Focal lengths longer than 5½ inches are not yet available.

The general appearance of some of the mounted lenses is shown in Fig. 5. This figure also shows the appearance of the condenser lenses described.

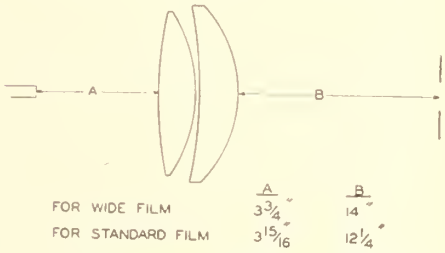

Fig. 5. Improved condenser for both standard and wide film.

Experimental work was begun by this company in 1925 on improvements in condensers. The results of those experiments were reported by Townsend and Stark in the Transactions of the Society of Motion Picture Engineers. This work was made the basis of further study beginning about the first of 1929 and led to a condenser combination illustrated in Fig. 5 in which the rear surface is cylindrical and the front surface paraboloidal.

Others Make Use of the Invention

This combination has been so well received that it has been reproduced in Europe. The fact that the Bausch and Lomb Optical Company had sold con-

densers of this type a year before the appearance of the foreign duplicates, that they were referred to in a paper presented by the writer at the S. M. P. E. meeting in Toronto in October, 1929, on the "Optical Problems of Wide Film Motion Pictures," and that letters patent have been granted to him on the construction (U. S. P. No. 1,783,481) would seem to dispose of the question of priority.

The Condenser System

The condenser system in question consists of a rear lens five and a half inches in diameter with a rear surface which is a convex cylinder and a front surface which is spherical, also convex. The front lens of six inches diameter is meniscus in shape with a rear concave spherical surface and a front surface which is parabolic.

The axis of the cylinder of the rear condenser is indicated on the rear surface and should be set horizontally. The combination yields an oval spot of light on the aperture plate which in wide film projection permits illumination of the whole area and in the projection of 35 mm. film permits somewhat more freedom for horizontal movements of the arc than spherical condensers. The peculiar combination of powers makes it possible to illuminate a spot, let us say, in the center of the field with a cone of light of sufficient angle to completely fill, in the vertical meridian, the aperture of a projection lens of f:2.3 relative aperture and to nearly fill the aperture in the horizontal meridian when used with a high intensity arc with 13.6 mm. carbons.

In order to obtain the maximum illumination with a given projection lens and light source it is necessary to design a condenser which will illuminate any point within the film aperture with a cone of light whose angle of convergence is equal to the angular aperture of the projection lens and at the same time, form an image, in the film plane, of the light source as large as the area to be projected. In order to secure a cone of light of the required angle and of reasonably even light distribution, condensers corrected for spherical aberration are necessary, hence the use of the parabolic surface. The size of the illuminated area depends on the size of the light source and magnification of the condenser. By suitable adjustment, sufficiently high magnifications of the light source can be obtained with small condensers but not in conjunction with high angles of convergence. Without going through all of the reasoning necessary to establish the fact, it can be stated that in order to meet the two conditions mentioned above with condensers of the old four and a half or five inches in diameter was an impossibility. It can be done with symmetrical condensers giving a round spot of light if made sufficiently large in diameter but not with lenses of six inches diameter. The use of the cylindrical surface permits the conditions to be met, however, for the vertical meridian with only a slight failure to meet them in the horizontal meridian using condensers of a maximum diameter of six inches and at the same time preserving a safe distance from arc to condenser, i. e., safe with respect to breakage of the latter.

These condensers are made of a heat resisting glass. It is remarkably free from the green color of some condenser glass and is next to fused quartz in its freedom from breakage. They are standard equipment with one prominent lamp manufacturer; a larger size, seven and a quarter inches in diameter, is standard equipment with another lamp maker, and a third is putting out lamps which are especially designed to accommodate the 6-inch size although he does not equip the lamp with any condensers.

Projection lenses and condensers, together provide for the projectionist optical equipment which marks a distinct advance over the lenses available five years ago for the projection of standard film. The purchaser of this equipment can, however, derive added satisfaction from the fact that with it he can project equally well from 70 mm. film when the time comes for this next advance in motion picture practice.

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GENERAL ELECTRIC IN MOVIE PRODUCTION

A SERIES of twelve short subjects produced by General Electric and titled "The House of Magic" have been offered to RKO by John Klenke, G. E.'s motion picture manager, to be sold to exhibitors under the same terms as regular theatrical shorts. According to Klenke, the subjects have been made so that they will classify with the non-advertising shorts of other producers.

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TALKIES FOR PENITENTIARY

PRISON reform through the medium of sound motion pictures, based upon a comprehensive plan conceived by Warden Preston E. Thomas, of the Ohio State Penitentiary, is to be placed in operation as soon as the installation of equipment is completed. Contracts have been closed with RCA Photophone for the installation of sound apparatus in the Protestant Episcopal Chapel at the penitentiary and it is expected the work will be finished within thirty days. The Ohio State Penitentiary, the first major penal institution to adopt this revolutionary method of moral reform, will be remembered as the scene of the disastrous conflagration in which nearly 300 convicts lost their lives. Warden Thomas believes that a great constructive work can be accomplished by the introduction of sound motion pictures into prison life and it is his present intention to present varied programs of instructive and educational value in addition to specially selected entertainment features. Photophone engineers will instruct one or more "trusties" in the operation of the sound equipment.

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STUDY CONDUCTED ON USE OF FILMS FOR ADVERTISING

(*Concluded from page* 14)

of the firm's products or services. Safety and efficiency of plant operation are being promoted and better personnel relations secured by many firms through exhibition of educational films within the organization itself.

The Commerce Department through a questionnaire addressed to these 2,000 concerns is seeking to determine how extensively the films are being employed for these various purposes and how efficient in point of results they are found to be. With regard to the public use of business movies in particular, the Commerce Department wants to know from each firm the number of people viewing its films in the course of a year in schools, theatres, trade meetings, etc., how difficult it is to arrange for showings, and the places in which the showings are found to be most profitable.

The planning and control of motion picture campaigns for business purposes, technical problems of production and distribution, and methods of measuring the efficiency of the use of films in the different branches of business are also dealt with in the Commerce Department's questionnaire.

What the Department finds out is expected to shed much light on the use and value of motion pictures in business, and help formulate plans for the most effective use of films. The experience record of past users of films in business will be of assistance, it is believed, not only in suggesting successful methods of procedure in securing best results with new productions, but also in helping to obtain a more extensive and productive use of films which may be already in use. A combined experience record in this field will also offer a standard by which the success of motion picture activities in general may be gauged.—*The United States Daily, January 7, 1931.*

An Examination for Projectionists

By James R. Cameron

In the Province of Ontario, Canada, Projectionists are to be Re-examined

IN Ontario it has been decreed that all projectionists holding operating cards are to be re-examined. This is being done, they claim, due to the increase in the number of fires in the motion picture theatres throughout the Province.

R. C. Buckley, chief of theatres for the Provincial Government, has issued a booklet containing 542 questions pertaining to the showing of motion pictures and sound motion pictures. The first page of this booklet carries the following statement:

"We are submitting herewith, for your guidance and instruction, a list of questions which every projectionist desiring a grade 'A' projectionist license should be able to answer correctly. Please note, however, that this list is not being forwarded to you as an examination paper, though you may be called upon to answer any questions on this form or any other questions having a bearing on the requirements to be met by motion picture projectionists. If there are any questions that you cannot answer correctly we would suggest that you ascertain from your instruction and text books the correct answers, so that your knowledge of motion picture projection and the reproduction of synchronous sound with motion pictures will be improved."

The following are a few of the questions contained in the booklet: What would cause poor quality or noisy output? What are the primary causes of noise in sound on film attachments? What general wiring precautions should be observed to minimize the possibility of external electrical disturbances? How is current obtained for disc method? How is the small electric current from the reproducer or the photoelectric cell amplified? How is current converted into sound? When a battery runs down or is permitted to discharge, what happens? How is amplification accomplished? Is it necessary for amplifier tubes to be matched; if so, why? What does a vacuum tube do when used as an amplifying tube? What is the "gain control" and what is its function?

What is a "flutter"? What would a low plate reading on the panel indicate? Describe the course of the sound from the pick-up until it reaches the horns. What could be done with a microphonic tube? What is the film attenuater? What is the photoelectric cell voltage on R.C.A.? Why are all wires carrying sound or speech, lead covered and again enclosed in conduit? If there was a difference of three points on the fader between two projectors, what might cause the trouble? Name the three essential elements that make up a reproducing system and their various functions. Which wire connects to the grid of the first tube from the photoelectric cell? What is the best method in cleaning dirty battery tops? What are the various elements in a vacuum tube? What is the function of the exciting lamp? What is "electrolyte" in batteries? Does a storage battery generate power? Why does the needle on a disc record travel from the center of the disc to the outside? On the Vitaphone disc is the sound record on the bottom of the track or groove, or is it cut into the walls of the groove? What is the mechanical "filter" on sound equipment? Which of the lines, the white or dark ones, make the actual sound from the film? What density does R.C.A. use in their recording? How can "motor-boating" be overcome? What is "specific gravity"?

Give two or more reasons why brushes on a motor-generator set will spark. What is a prismatic condenser? Show how you would adjust the lamp and mirror when using Mazda equipment to get a correct focus. Give approximate distances between: a, Centre of mirror and filament; b, filament and condenser; c, condenser and aperture; d, lens and rotating shutter. Give some of the advantages of Madza equipment. What is a "grid type" rheostat? What prevents the burning away of the lamp metal due to excessive heat from the high intensity arc? If a rheostat coil burns out, how would you make an emergency repair? Why are some starting switches on motor-generators and larger equipment enclosed in oil? Show by diagram the wiring in a circuit of a polarity reversing switch? What is a Hi-low lamp? What is the average amperage used on a, old style arc lamp, b, high intensity, c, reflector arc, d, Hi-low lamp?

Show by diagram balanced load of two arcs, two motors, and two rheostats on a three wire 110- and 220-volt circuit. What is meant by the safe carrying capacity of a wire?

Define the following: Flicker, condensing lens, collector lens, converging lens, plano lens, plano-convex lens, meniscus lens, a volt, an ampere, an ohm, a watt, a kilowatt, a horsepower, direct current, alternating current, a cycle, a megohm, a ground, an electric arc, a short circuit.

What advantage is there to gears that are spiral cut? Why should aperture tension be varied when using new and old film? What is the standard aperture size? Which make of projector has an actual faster movement? What is chromatic aberration? What is spherical aberration? What is meant by the optical axis? What is absorption of light?

These are some of the more important of the 542 listed in the new booklet and whoever drew them up certainly covered the whole question of projection in a very thorough manner.

▲

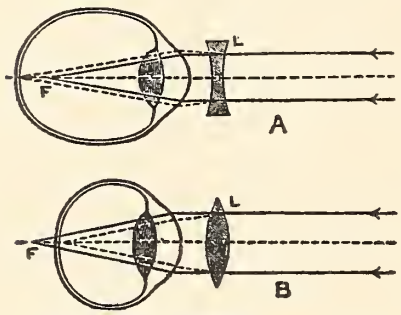
FRED NIBLO, SECRETARY OF ACADEMY

FRED NIBLO has been elected Secretary of the Academy of Motion Picture Arts and Sciences, succeeding Frank Woods, resigned. Mr. Woods has been awarded a life membership in the Academy.

OPTICS OF SPECTACLE LENSES

THE image on the retina is upside down and it would seem that we should see everything upside down.

This idea comes from the conception that the brain is something which looks at the image on the retina from behind, whereas the light which falls upon the retina simply stimulates the optic nerve, and this stimulation when carried to the brain produces certain changes which give us the sensation of light. It is not known what changes are produced in the brain by the stimulus from the optic nerve, nor how these



From "Everyday Physics" (Macmillan)

How the Spectacles Work

changes produce the sensation of light.

There is one striking difference between the eye and the camera, and that is in the method of focusing.

The camera is focused by moving the lens back and forth, but the eye is focused by changing the shape of the lens. When the eye is viewing an object near at hand, the muscles of the eye contract the lens so that it is more convex. When it is viewing a distant object, the muscles extend the lens so that it is less convex. That is, when we look at an object near at hand, the lens of the eye is smaller and thicker; and when we look at a distant object it is larger and thinner.

Many people can see things at a distance, but not those close at hand. In such cases the eyes are far-sighted.

The eye lens can not be made thick enough to focus, on the retina, light from objects near at hand, and the image would be formed behind the retina, as shown in B, Fig. 1. To overcome this difficulty spectacles with converging lenses are used, and the proper lens is one which will produce just enough convergence to enable the eye to focus the image on the retina.

Some people can see things near at hand, but not those at a distance. In such cases the eyes are near-sighted.

The eye lens can not be made thin enough to focus, on the retina, light from a distant object, and the image is formed in front of the retina, see A. To overcome this difficulty, spectacles with diverging lenses are used, and the proper lens is one which will cause the light to diverge to such an extent that the eye can focus the image on the retina.

If, instead of ordinary near- or far-sightedness, there are other defects in the lenses of the eye, distorting the image, these can often be corrected by a compensating distortion of the spectacle-lens. After the eyes have been carefully tested by an oculist, he gives directions that enable the optician to grind a lens of exactly the proper shape to correct these eccentricities of vision.

The foregoing is abstracted from the book *Everyday Physics* by Carlton J. Lynde (*MacMillan Company*).

▲

PICKUPS

In the March issue of PROJECTION ENGINEERING will appear a complete technical article describing and illustrating pickups as used in theatre reproduction, and for recording.

▲

RADIOVISION PROGRAMS IN THE MAKING

(*Concluded from page* 16)

sary, which has heretofore constituted a serious drawback, but today the amplification problem is solved.

The outdoor camera pickup is hardly a separate classification, since it is little more than taking the camera outdoors so as to pick up news features and personalities in the public eye. However, in view of the fact that the average telephone line of today cannot handle the necessary wide range of frequencies called for by television images, it is necessary to use a portable transmitter as part of the equipment. Excellent results have been obtained by means of ¼ kw. and ½ kw. transmitters out in the field, side by side with the camera. Here again, the usual broadcast feature of a prominent person or news event may be handled as at present, while the radiovision accompaniment may be picked up alongside the microphones.

It's the showman's turn next. The engineer has done an excellent job so far, in bringing radiovision up to the commercial point. The showman must take the radiovision technique, with its four pickup methods, and endeavor to build up regular programs of real entertainment value. Once the programs are on the air on a schedule basis, with something of interest to the average family, the production man can come along with a production sufficiently great to bring costs down to within reason. The merchandiser can complete the picture by selling radiovision equipment to most of the homes now equipped with sound broadcast receivers.

Just as Station KDKA of the Westinghouse organization took radio telephone experiment and made of it the broadcasting institution, laying the foundation for the vast radio industry that followed, so proper showmanship must convert the radiovision experiment into the organized radiovision entertainment, paving the way for a much needed industry.

Will history repeat itself? That's the question which awaits an answer in the form of prompt and capable action.

▲

AMPLIFICATION IN SOUND MOTION PICTURE WORK

(*Continued from page* 19)

transformer coupling is nearly always used with these transformers. All of the types of tube couplings described here are employed in the various amplifiers used for sound recording.

A Single Recording Channel

In Fig. 4 is shown a block schematic layout of a single recording channel. This type of diagram is given the name "block schematic" because simple squares are employed to represent the various pieces of equipment, and the groups of connecting wires between them are shown as single lines. The special double-hole jacks that are connected in the input and output circuits of all of the main pieces of apparatus in the installation are not represented in this diagram because they would only serve to complicate it and make it confusing. However, it should be remembered that they are there and that they permit any part of the equipment to be patched in or out of the circuit at will. By means of multiple jacks connected to the ends of lines that terminate in the center bays of both channels, amplifiers in one channel can be patched in circuit in the other channel in place of the equivalent amplifiers that may be giving trouble. This is done by means of special "patch cords," which are short lengths of two-wire conductor with plugs on each end having two pins that fit into the two-hole jacks in the jack fields of the amplifier bays. This arrangement provides an extremely flexible amplifier system that is very convenient to operate.

(*To be continued*)

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MIKES AND BLIMPS

The Versatile Crane Microphone and the subject of Camera blimps will be taken up in special, illustrated articles in the March issue of PROJECTION ENGINEERING.

GORDON S. MITCHELL

We present herewith a likeness of Gordon S. Mitchell, Sound Engineer with Universal Pictures Corpn., Universal City, Cal.

Mr. Mitchell received his technical training at the California Institute of Technology and the University of California. He is a Lieutenant in the 975th., Coast Artillery, Fort McArthur, Calif. Several of the excellent technical stories dealing with sound engineering which have appeared in PROJECTION ENGINEERING during the past year were prepared by Mr. Mitchell.

▲

GENERAL ELECTRIC PRODUCTION

"STEPPING Ahead," the first all-color, all-talking, professionally directed industrial motion picture film, has been produced by the Motion Picture Section of the General Electric Company, Schenectady, for the use of the National Lamp Works of the company at Cleveland. The speed with which the production was effected also sets a record—the idea was conceived December 1, the scenario was started December 8, and the photography was started December 11 in New York, Chicago and Schenectady. In one week from then the picture was complete. On January 10 the film was given its premiere showing at Cleveland, and on January 15 the production was routed for showing to more than 3500 lamp distributors.

The two reels (2000 feet) of film include a night view of New York's gaily illuminated Broadway, the interior of the National Broadcasting Company's studios in Chicago where sun-lamps are employed as ceiling fixtures, and numerous studio scenes made in Schenectady to portray the progress of light, including floodlighting, Colorama, street lighting, and incandescent lighting in general.

For the General Electric Company the work was under the supervision of John Klenke. Alvin Wyckoff, formerly associated with Cecil DeMille in the production of "Hell's Angels," cared for the direction and supervision of the picture for Multicolor, Ltd. James Williamson, cameraman, and Earl Pearsall, technician, both of Hollywood, assisted Mr. Wyckoff.

▲

A NEW TYPE OF FILM

A NEW type of motion picture film, about three times as "fast" as that previously in use, was announced on February 5, by the Eastman Kodak Company to a group of leading cameramen and laboratory technicians. The new film is expected to work marked changes in studio technique, by permitting greater freedom in making sound pictures and by cutting down the necessary amount of lighting, thus reducing heat, glare, and cost.

The faster film is described by motion picture engineers as the greatest advance in motion picture materials since the introduction of panchromatic film eighteen years ago. The motion picture industry, subsequent to that development, went over almost entirely to panchromatic film, which, in monochrome, portrays colors in their proper tonal relation to each other instead of with distorted values.

The new type of film was announced as possessing increased panchromatic qualities in addition to its greatly increased "speed." Increased speed, in cinematographic terminology, means simply the ability to expose a photographic image with less light.

Since the advent of sound in motion pictures three years ago, the Eastman Kodak Research Laboratories have experimented in the direction of developing a film to meet present conditions in the sound studios, where the substitution of incandescent lighting for electric arcs presented a new photochemical problem.

The Arrival of Incandescents

The panchromatic film heretofore in use was developed for exposure with arc lighting. When the change to incandescent illumination swept over Hollywood, the film was adapted to the new conditions so far as that was then possible. The new type of film, on the other hand, was specially made for use with the "inkies," as Hollywood calls incandescent lights, and has a sensitivity to red and green hitherto undreamed of. Incandescent light contains a higher proportion of red than does the light from arcs.

The increased speed and extraordinary color sensitivity of the new film are expected to be of particular usefulness in natural color photography, where the great concentration of light hitherto necessary has been a drawback.

Another practical advantage claimed for the supersensitive film by Eastman representatives here is an increase in the possible "depth of focus" in sound film photography. The use of incandescent lighting made desirable the wider opening of lens diaphragms to let additional light into the cameras. This, in turn, by a law of optics, greatly diminished the range within which the actors could move and yet remain in focus. When sound came to the movies, depth of focus became of increasing importance because it is irritating to audiences to hear a clear voice coming from an out-of-focus actor.

Greater Latitude in Focusing

With the greatly increased speed of the new film, it will henceforth be possible to "stop down" lenses, increasing the depth of focus and thus permitting greater latitude to directors in moving their actors about before the camera. The characters will no longer have to remain in a narrow plane at a fixed distance from the lens under penalty of blurring into the background or becoming fuzzy in the foreground.

An alternative advantage of the new type of film is the possibility of reducing the amount of light to one-half or one-third the present quantity necessary for sound picture cinematography. In practice, it is expected that the studios will compromise between the maximum reduction of lighting and the maximum gain in depth of focus, taking partial advantage of both benefits offered by the new type of material.

Headquarters of the International Projector Corpn., 90 Gold Street, New York, on the right, and National Theatre Supply Co., 92 Gold Street, on the left.

New Developments and News of the Industry

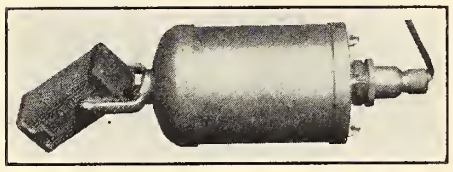
THE RIBBON MICROPHONE

By Lowell V. Calvert*

A new type of microphone, in process of development for the past several months and successfully operated in studios which employ the RCA Photophone system of recording, has been perfected. The new device, which marks a revolutionary step in the transference of sound to film and which is known as the "Ribbon Microphone," was developed by Dr. Harry F. Olson, research engineer, who specializes in loudspeaker and microphone operations.

Many difficulties heretofore experienced in the recording of sound motion pictures have been solved by the use of the "Ribbon Microphone." Among other revolutionary virtues, it has what are known as "directional sound pickup" characteristics, by virtue of which sounds coming only from certain directions are picked up, and sounds coming from other directions are completely ignored. This enables the microphone to be used in reverberant sets, in such a way as to pick up the voices of the actors and at the same time considerably reduce the amount of reverberation picked up. Another way in which it can be used is to pick up an actor's voice and at the same time ignore the noise of the camera. Up to the present, bulky and inconvenient hoods or "blimps" have been used over cameras, in order to reduce the noise picked up by the microphones. These clumsy encumbrances are now obsolete.

The principle on which the "ribbon microphone" operates is that of induction of electric current in an extremely thin and light corrugated aluminum ribbon, placed



between the poles of an electric magnet. This aluminum ribbon is only one ten thousandth of an inch thick, 3/16 inch wide and 2 inches long. The minute changes in air pressure occasioned by sound waves cause this ribbon to flutter or vibrate between the magnet poles, and electric currents are thereby set up in it. These currents are led to a transformer, which is connected to a vacuum tube amplifier of the conventional type.

The "ribbon microphone" proper is contained in a perforated box. The output of the microphone is fed to an amplifier. A plug and cable located at the top of the amplifier runs to a standard recording amplifier. The accompanying illustration shows the microphone tilted at an angle to pick up action located below the microphone. Its efficiency of pickup is the greatest in the direction normal to the face of the microphone. Its reception in the plane of the face of the microphone is zero. Thus if objectionable noises such as a camera are placed in this plane this noise will not be picked up by the microphone.

Manager of Recording Operations, RCA Photophone.

COMMERCIAL FILMS

The use of talking motion pictures as a medium of public education in the investment field was demonstrated for the first time in December before a group of investment bankers at a private film showing held at the Tavern Club in Chicago.

The film is the work of the Burton Holmes Studios, and was developed through the cooperation of the Administrative and Research Corporation of New York, sponsors of Corporate Trust Shares, a fixed investment trust. The picture, which is titled "An Investment in American Prosperity," depicts in story form the size, strength and broad scope of activity of twenty-eight of America's leading corporations—such companies as United States Steel, New York Central, Standard Oils, General Electric, American Telephone & Telegraph, International Harvester, duPont and others.

The picture, believed to be the first of its kind ever produced, will be placed at the disposal of a group of more than 800 investment houses and banking institutions throughout the country, who will join in the educational program by arranging complimentary local showings of the film.

▲

HEAT RESISTING CONDENSERS

The Fish-Schurman Corporation, 45 West 45th Street, N. Y. C., after extensive laboratory tests, produced a condenser of heat resisting Ignal glass combining superior optical qualities. Ignal glass is a specially tempered glass and can withstand extreme changes of temperature with no danger of cracking and will outlast condensers made of ordinary optical or other glass. The following table points to the technical phases of Ignal glass. which make it adaptable for the purpose to which it has been adopted.

Cooefficient of Expansion:
25– 75 degrees C—399 x 10—8
175–225 degrees C—430 x 10—8

Softening Point:
630° at 1 mm. thickness
640° at 2 mm. thickness
675° at 5 mm. thickness

N. D. 1.496.
Hydroscopic glass I.

▲

RADIOVISION EQUIPMENT PRICES REDUCED

Radio television is going to make a strong bid for public support during 1931, according to the statement of D. E. Replogle, assistant to the president of the Jenkins Television Corporation.

"Coincident with the unusual activity of the press with regard to television developments and possibilities, together with greatly increased production facilities at our new plant in Passaic, N. J., we find it possible to reduce the list prices on our home television equipment," states Mr. Replogle. "Dealers can now afford to stock television equipment and to demonstrate radio television possibilities to their clientele, thereby expediting the public acceptance of this form of home entertainment.

"The Jenkins 1931 line will definitely appeal to two classes of buyers: first, kits will readily interest home set builders and tinkers who were the mainstay of the radio industry in its early years; secondly, completely manufactured units are priced right to appeal to the middle class man who desires television in an immediately usable and living room form.

"Meanwhile, television broadcasting stations are consistently reaching out with good picture detail, and most of the television broadcasters are contemplating increases in power, ranging up to five times their present output. Therefore, buyers of home television equipment are assured the proper signals and entertainment.

"We anticipate an immediate reaction on our price reductions. It is our belief that radio television is here. The engineering work has been done to the point where the commercial stage is at hand. The job from now on is one of merchandising as well as engineering," concludes Mr. Replogle.

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MICROPHONE STANDS

Jerome A. Schwartz, 246 5th Avenue, New York, has entered the field with a line of microphone stands, special boxes and incidental steel work including relay racks. Steel work to specifications is being featured.

Some of the talking points in favor of the microphone stands are; concealed wiring on all models, table and desk models have felt-lined bases, while the floor type has been designed to minimize the toppling-over hazard. All models are beautifully plated with a rich brown English bronze finish which matches with walnut.

▲

SPRAGUE TO ENTER FIELD OF HOME TALKING MOVIES

R. C. Sprague, president of the Sprague Specialties Company, Quincy and North Adams, Mass., announces:

"After a careful survey into the manufacture and merchandising possibilities of a home talking moving picture machine, we have contracted for the exclusive manufacturing and sales rights for a unit that can be produced at an attractively low list price.

"It is our purpose to manufacture two models for sale to distributors and dealers throughout the United States and Canada. Model A will consist of a talking picture unit to plug into a radio set using the amplifier and speaker of the radio. Model B—a talking picture unit incorporating an amplifier and speaker to operate independently of a radio set. This unit, will be attractively priced, simple in construction, and easy to operate.

"Merchandising authorities consulted to date are enthusiastic, and we see no reason why the demand for this unit will not closely parallel that of the early days of radio receivers.

"We also intend to make available for radio set manufacturers a compact unit consisting of the turntable and projector mechanism, so that manufacturers can produce for their trade a complete talking picture machine, together with a complete radio set at a reasonable price.

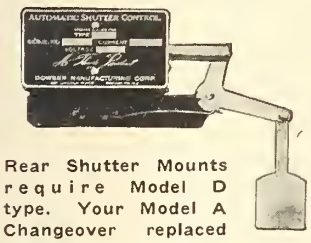
"Agreements have been made with some of the leading film producing companies whereby one, two and six reel feature talking pictures released by them will be available to all dealers of Sprague machines."

DEPENDABLE PROJECTION--CONTINUOUS SHOWS--

The Standard Changeover

It works...

Fits Motlograph Model F, Simplex and Super-Simplex, Sure-Fit, with or without Rear Shutter Mounts.



Rear Shutter Mounts require Model D type. Your Model A Changeover replaced with Model D type. Liberal allowance for Model A.

Our sales argument?—A revolutionary theory in changeover successfully applied—that's all! But applied so well that already 3000 Dowser Automatic Shutter Controls have been installed throughout the country.

The theory?—The smallest shutter operating through the smallest space at a minimum current consumption yields maximum efficiency. And that logical place for the changeover is the smallest cross sectional area of the light beam.

Send for literature.

AUTOMATIC SHUTTER CONTROL
with 3-wire circuit foot switch

DOWSER
691 LINCOLN PL. MANUFACTURING CORP. BROOKLYN N.Y.

DIRECT READING

TYPE 586 Power-Level Indicator

An open clearly marked decibel scale makes the General Radio TYPE 586 Power-Level Indicator a truly direct-reading instrument. The time saved and the freedom from costly mistakes such a scale insures are advantages readily appreciated by the monitoring operator in the broadcast and recording studio.

If you are not familiar with this instrument, a request on your business letterhead will bring you a catalog description. Please ask for Bulletin 932-P.

GENERAL RADIO COMPANY
Offices Laboratories Factory
CAMBRIDGE A, MASSACHUSETTS

SUPER-LITE LENSES

Wisely Chosen By America's Best Theatres

New Bifocal Super-Lite Lens

An adjustable focus lens with a wide range of focl for both silent and sound film.

Series III. Super-Lite Lens

Standard full Half-Size lens furnished in short focus as low as 4" E. F. and up to 10" E. F.

Series IV. Super-Lite Lens

Full 3" diameter lens to meet the demand for more light for longer throws. 6" E. F. to 10" E. F.

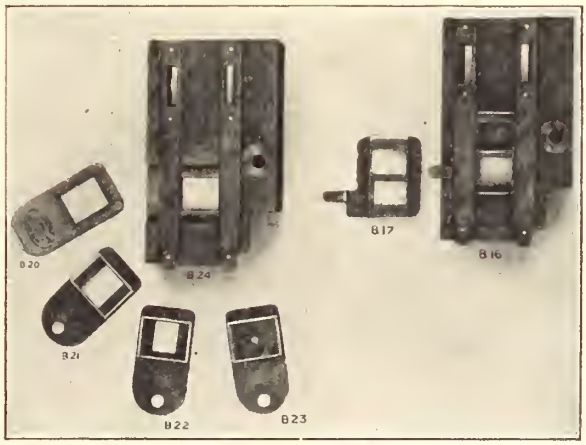
Quality Guaranteed

PROJECTION OPTICS CO., INC.,
330 LYELL AVE.
ROCHESTER, N. Y. U. S. A.

BLUE SEAL HEAT RESISTING IMPROVED FILM TRAPS

FOR SIMPLEX PROJECTORS

MADE OF AN IRON ALLOY. Guaranteed not to Warp under the intense heat of the Arc Spot. A necessity for the Perfect Projection of "Sound" Pictures



B-16 Film Traps with Sliding Double Round Corner Apertures, one Aperture for Disc and Silent Film and one cut Proportional for Movietone Film to be used with our Adaptors	$30.00
B-17 Sliding Double Aperture Plate	6.00
B-24 Film Trap with individual mats for silent, movietone and magnascope effect. Traps complete with all mats	30.00
B-20 Master Plate to hold mats stationary	1.50
B-21 Standard Aperture with Square Corners	1.50
B-22 Proportional Movietone Aperture with Square Corners	1.50
B-23 Blank Mat (CAN BE CUT ANY SIZE APERTURE)	1.50

Manufactured by

BLUE SEAL PRODUCTS CO., Inc., BROOKLYN, N. Y.
260 WYCKOFF ST.
Manufacturers of Motion Picture Accessories Since 1913

BABY SPOTLIGHT

The Best Devices Company, Cleveland, Ohio, has in stock a new spot light.

"Best" Baby Spotlights are extensively used for commercial lighting effects in display windows, in banks, office buildings and factories; used in theatre work for footlights, border lights and lobby display board illumination; and used in any other places where individual lighting is required. Photographers have found "Best" Baby Spotlights unusually effective for background and highlighting illumination.

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AN ADVERTISING PROJECTOR

As an inevitable result of the progressive change that revolutionized the motion picture industry when audibility supplanted the printed title in screen entertainment, a novel automatic advertising projector, designed to accommodate standard-sized sound motion picture film, has been perfected and will soon be introduced to the public. The new device is the product of RCA Photophone, Inc., in collaboration with the Auto Cinema Corporation, which has had a silent motion picture advertising projector on the market for several months. The machine itself, a compact piece of engineering workmanship, operates within a neatly modeled metal housing occupying a space less than two feet square. The projector is motor-driven with power supplied from an ordinary lamp socket. Projector, amplifier, motor and six-inch speakers are collocated within an attractively designed cabinet, similar in appearance to a radio console, which stands about five feet six inches high. The picture is thrown upon a transparent screen, eighteen by twenty-two inches in dimension near the top of the cabinet and in the line of vision of the average-sized person when standing. The entire equipment, including cabinet, weighs less than one hundred pounds. When placed in operation, the film is endless self-rewinding, permitting repetition of the subject indefinitely. The sound amplification can be controlled to any desired volume.

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WEBSTER ELECTRIC COMPANY

To supply a direct sales and service contact in a rapidly developing market for its products, the Webster Electric Company has opened a New York office at 15 Laight Street. This office will be in charge of Arthur Rocke, manager, and T. H. Johnston, sales engineer.

The Webster Electric Company, with main offices and factory at Racine, Wis., has been developing and producing precision electrical devices for over twenty years. Webster electric pickups and Webster amplifying equipment, are said to have natural, life-like sound-reproducing qualities.

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SET OWNERS ARE SHOWN CAUSES OF INTERFERENCE

In the interests of improved radio reception through a clearer understanding, by the broadcast listener, of the causes, manner of distribution and methods of suppressing radio interference, a motion picture has been prepared by the Radio Interference Committee of Southern California and is being made available to radio clubs, Chambers of Commerce, trade associations and service clubs by the Tobe Deutschmann Corporation, Filterette Division, of Canton, Massachusetts.

The first scene of the film is of a modern receiver being installed in a home. The installers provide a short inside antenna, instruct "Mrs. Prospect" in the operation of the receiver and leave her enjoying a good program.

The action of the second scene takes place in the evening, showing the arrival of the salesman to close the sale, and indicating his discomfiture when radio interference causes the listeners to fear that an explosion has occurred within the receiver. Just as all salesmen have done since the advent of the a-c. operated receiver, this salesman hurriedly tries to adjust the station selector and volume control to obtain clear reception, but with no success. He then tries to explain the interference situation, but is obliged to leave most of this for the interference investigator, who appears in the next scene.

Because "Mrs. Prospect" is convinced that the receiver is responsible for the unpleasant sounds introduced in her home, the investigator shows, by removing the antenna connection from the receiver, that the disturbance originates outside the receiver. He then explains the many causes of radio interference. The receiver fades out and the electric refrigerator appears. An animated wiring diagram shows the interference at the starting or stopping of the compressor motor, and the investigator explains just when interference may be expected from an electric refrigerator.

Next, in rapid succession, are shown a heating pad, bottle warmer, sewing machine, vacuum cleaner, adding machine, dictating machine, fan, drink mixer, fruit juice extractor, vibrator charger, bulb charger, motor generator set, cash register, violet ray and diathermy. The correct manner of filterizing home and office appliances is shown both in picture and in animated wiring diagram. The direct radiation of high frequency energy from a diathermy machine is shown, in animated diagram, and the type of shielding required for the suppression of this interference is explained.

The inductive transfer of interference from one circuit to another is shown, and the importance of erecting the antenna out of the field of interference is stressed. With further animated diagram, the manner in which interference enters the receiver, through antenna, power line, a ground wire is depicted. The procedure to be followed by the set owner to make his receiver as little as possible subject to interference is explained in detail.

After so complete a discussion of the interference question, and after the substitution of a properly erected outside antenna for the makeshift indoor antenna first installed, "Mrs. Prospect" is better satisfied with her receiver, and in the closing scene the salesman receives his check from another satisfied customer.

To provide moments of relaxation for the layman who may not be able rapidly to absorb the semi-technical subject matter of the film, a number of shots of a battle between a mongoose and a cobra are introduced. As these scenes are being shown the interference investigator shows the similarity of interference to the deadly cobra, and of the mongoose, which kills the cobra, to the Filterette which kills radio interference.

The picture is printed on standard 16 mm. film for use in home projectors.

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COIL WINDERS

Edward Spiegler, General Radio Winding Company, 214 Fulton Street, New York, announces his entry into the field of producing high grade coils. Mr. Spiegler is in the market for additional coil winding machines.

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AMPLION MOVES

On February 1 the Amplion Company, Inc., moved to 38 West 21st Street, New York.

▲

SCHOONMAKER MOVES

The Schoonmaker Equipment Corpn., manufacturers of Raytone sound screens has moved to larger quarters, at 276 Ninth Avenue, New York.

▲

AMERICAN SALES COMPANY MOVES

The American Sales Company, formerly at 21 Warren Street, New York, has moved to 44 West 18th Street.

CONDENSER TRANSMITTERS

In order to meet requirements of certain new mixing equipment in which a 50 ohm input is used, the Jenkins and Adair Company, Chicago, have brought out the Type D-6 and D-12 condenser transmitters, and are prepared to change Type C instruments to 50 ohm output.

No change is made in the transmitter unit or the amplifier housing. A new amplifier chassis is substituted, which is the same in general construction as the type C except that the output transformer has four secondary terminals, numbered 1, 2, 3 and 4. These represent two windings, which in series give 200 ohms, and in parallel, 50 ohms output impedance. The 90 volt lead is not used, and a series resistance is inserted in the plate circuit of the tube so that all high voltage service comes from the 180 volt connection.

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PORTABLE SOUND ON DISC TURNTABLE

All parts of the Mellaphone portable are cast aluminum, insuring lightness and portability with exception of the turntable disc, which is cast steel plate insuring smooth quality of reproduction of voice and music.

Mellaphone portable uses special gears. Together with these gears are embodied an ingenious spring suspended filter which also tends to guarantee excellent tonal quality. Audak pickups are furnished and may be had in either high or low impedance and tuned models. An especially designed fader is included. The Mellaphone portable motor drive is easily attached. No drilling or altering of the projector is necessary. It is not necessary to send the projector to the factory.

Mellaphone portable may be attached to either DeVry, Acme, or Holmes or any projector on the market. The complete turntable is furnished with a compact carrying case. Portable amplifier and speakers are also supplied.

▲

ROTH ELECTRIC SUPPLY

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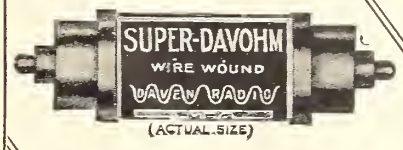

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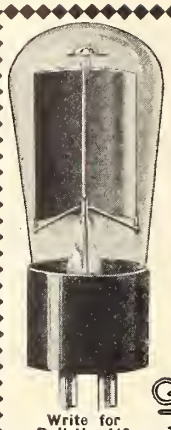

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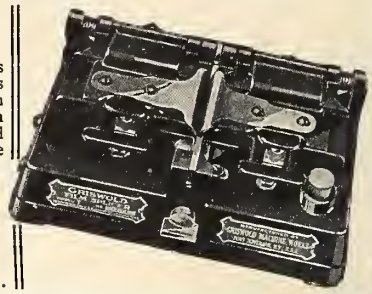

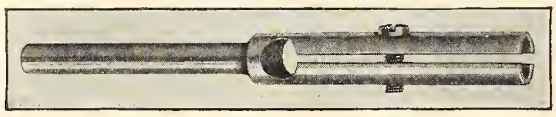

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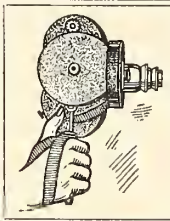

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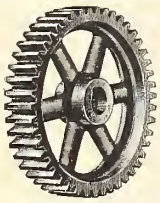

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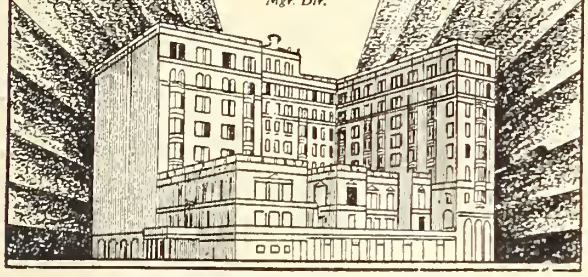

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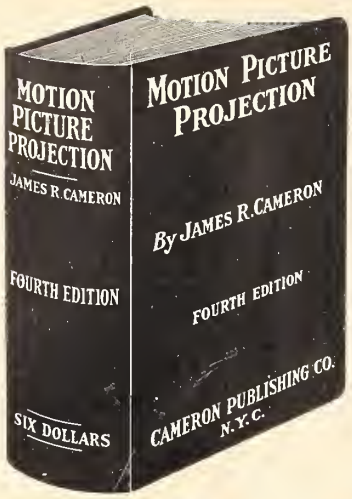

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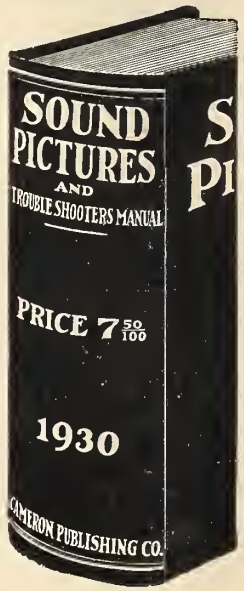

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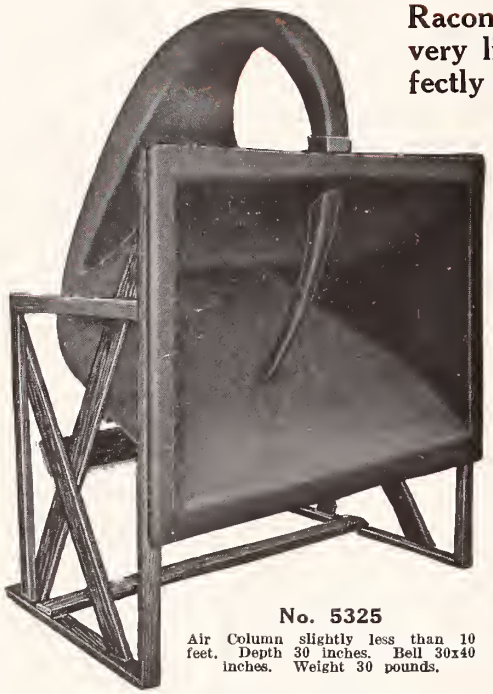

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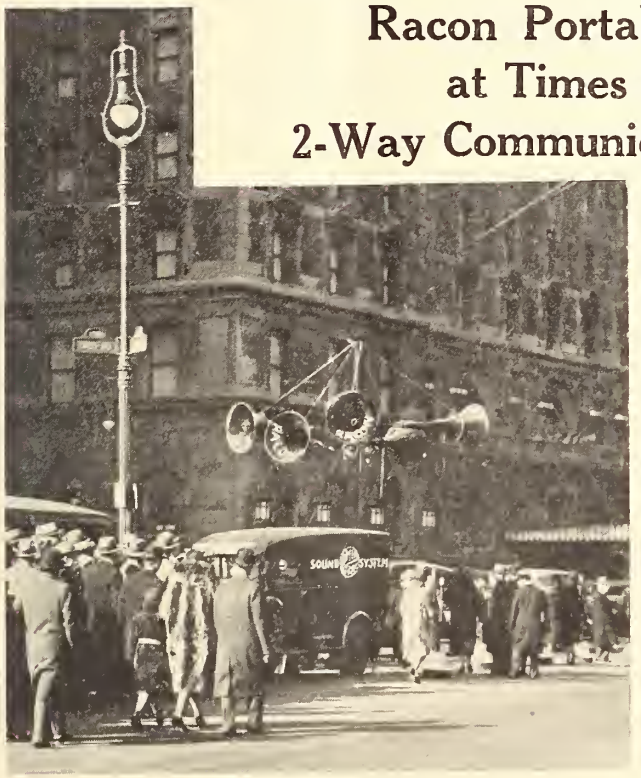

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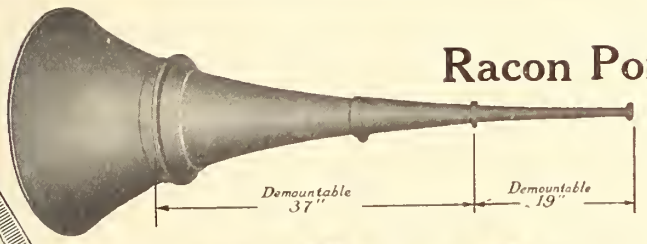

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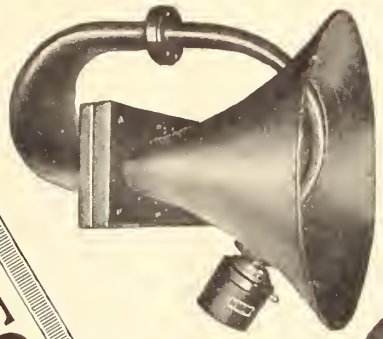

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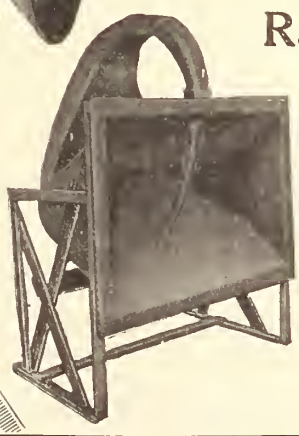

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Editorial

April, 1931

THE MARKET FOR SOUND EQUIPMENT IN THEATRES

ACCORDING to the latest authoritative statistics there are 18,000 moving picture theatres in operation in the United States. This is aside from an additional 11,000 theatres which are either temporarily, or permanently closed. Of the theatres in operation 64.9 per cent are equipped for sound projection. That is, 11,560 are so equipped.

Of the theatres having sound facilities a total of 5,619 are equipped with ERPI or RCA Photophone Systems. This leaves 5,941 theatres which have in service sound systems manufactured by a score or more of independent manufacturers of sound amplifying apparatus.

Of the existing 18,000 theatres operating, less than one third are equipped with sound systems manufactured by the two largest companies. There remain 12,381 theatres which constitute the market for both the independent manufacturers and the two large companies.

The present aggressive sales projects on the part of all manufacturers of sound equipment are understandable when one considers the magnitude of the business yet to be procured.

▲

THE STANDARD RELEASE PRINT

EVERY projectionist who has not already received a copy of the questionnaire entitled, "Survey on How to Improve the Release Print Standard," should procure a copy from Lester Cowan, manager of the Academy Technical Bureau, 7046 Roosevelt Blvd., Hollywood, Calif.

A primary aim of the Standard is to keep the print in better condition for subsequent runs. The conscientious projectionist who endeavors to put on the best possible sound presentation at every showing of a given picture, under difficulties experienced with the prints he receives, is the man to be considered in any contemplated technical betterment.

The technical bureau of the Academy is desirous of receiving the information called for in the questionnaire referred to and all projectionists should avail themselves of this opportunity to air their views.

▲

THE S.M.P.E. CONVENTION

THE Spring meeting of the Society of Motion Picture Engineers will be held at Hollywood, Cal., May 25 to 29, inclusive. The technical sessions at this meeting will be highly important and instructive. There are to be papers on color photography, studio practices, film characteristics and processing, and sound recording. There will be several papers on each of these timely subjects, each paper prepared by engineers closely in contact with the details of theatre projection work.

Every one identified with the technical side of the theatre who can make the trip should go to Hollywood for this convention.

▲

SOUND AMPLIFIERS

WITH the astonishing growth of the sound amplifier business in recent months it is interesting to speculate upon the greater extensions of the service which would be under way if business conditions were normal. There seems no end to the situations into which modern sound amplifying systems fit economically and profitably.

A noteworthy development is that a very considerable number of the applications of sound reproduction and amplification now being engineered were sold by local electrical contractors, radio service managers, and theatre projectionists. There are upward of thirty thousand communities in the country where one or more sound installations are almost certain to be placed in service within the next year or two, for commercial industrial, auditorium, sports, and outdoor amusement purposes.

These installations are in addition to sound-picture theatre requirements, and aside from the hundreds of installations made and to be made in hundreds of cities and large towns.

The requirements of the smaller communities offer opportunity for many of the smaller manufacturers of sound equipment. Although the points of sale are widely scattered, in the aggregate the business is sure to be of gratifying proportions.

▲

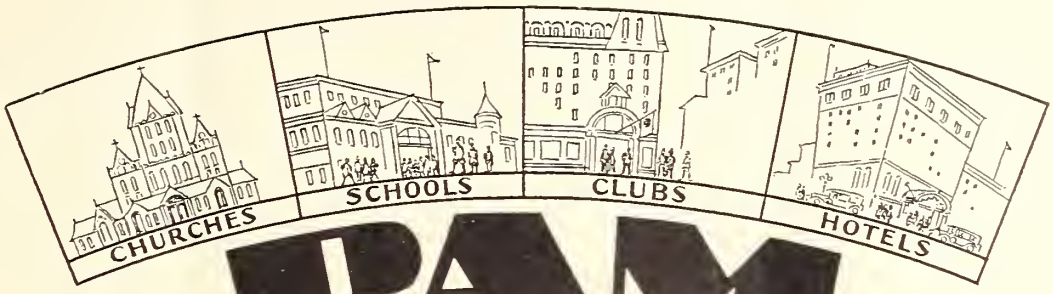
$8,000,000 FOR FILMS

SEVERAL foreign countries whose film needs are measured in millions of feet a year bought from America in 1930 more than in 1929. The record of sound film shipments to the leading markets in 1930 discloses some encouraging signs of improvement in this trade.

Commerce Reports says the total value of all film exports in 1930 exceeded $8,100,000.

Donald McNicol

Editor.



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Send for twin folders PE4; one descriptive of the PAM-100 and the other of the MIK-100.

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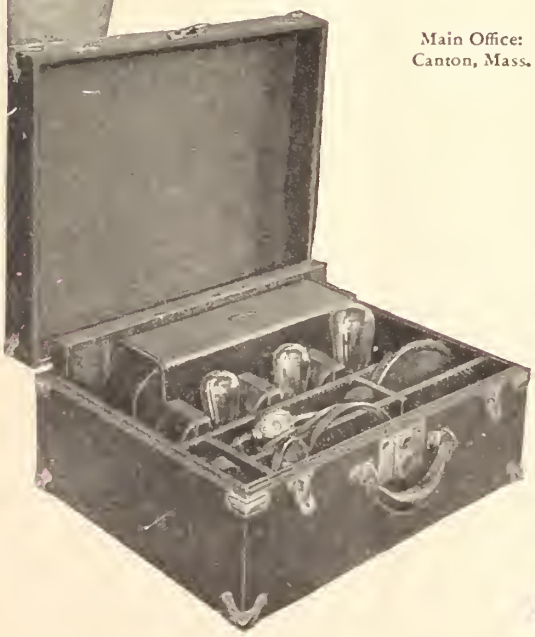

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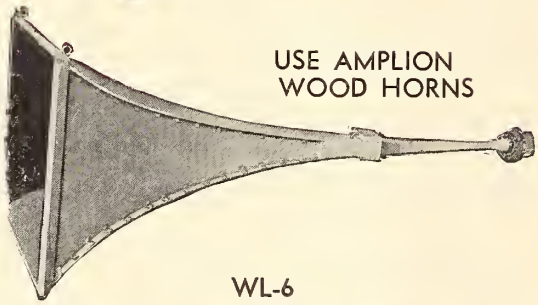
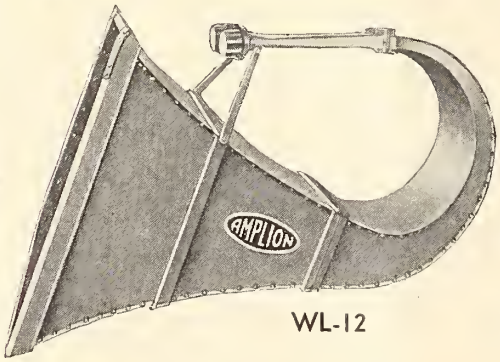


USE AMPLION WOOD HORNS

WL-6



WL-12

AT BASEBALL PARKS important announcements and league results are announced thru Amplion equipment. An Amplion Public Address System is operated at the Polo Grounds in New York City.

AT FYLING FIELDS, above the noise of motors and expectant passengers, flying schedules, aviation news and last minute words of instruction are instantaneously announced through the powerful trumpet horns.

IN SCHOOLS AND CHURCHES Amplion's public address system has had widespread acceptance. For amusement and educational diversions phonograph records may be played on the electric turntable.

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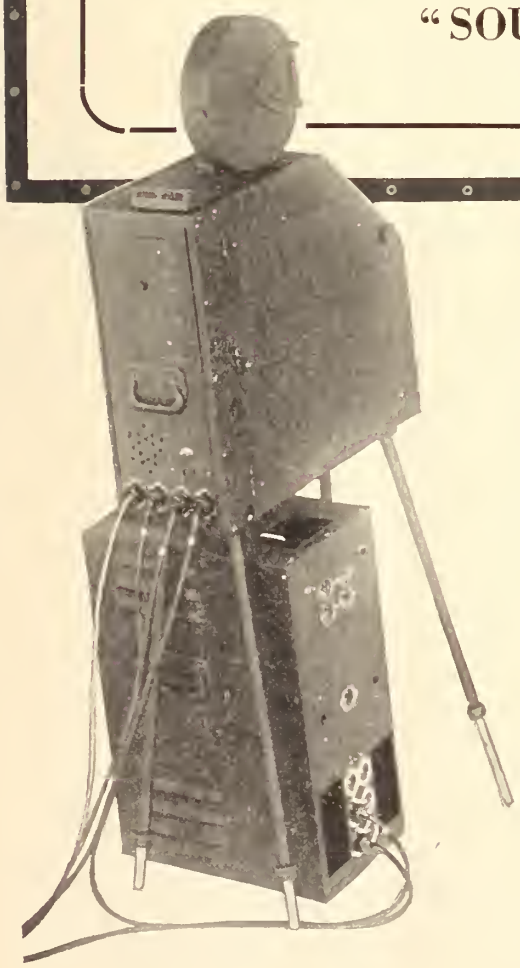

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Projection Engineering

APRIL, 1931

Typical Public-Address Installations

By Henry L. Williams

Although the Requirements for Each Installation Are Special, There Are Various Fundamentals Common to All.

When municipalities or public authorities want a public-address or centralized radio system installed they usually retain an engineer to draw up definite specifications. Private concerns, on the other hand, generally leave the layout to the individual contractor, so that each sound engineer designs his own system and the resulting estimates may vary as much as 100 per cent.

This is one of the reasons why the sound installation concerns should have a really competent engineer on the staff, even though they specialize in the use of factory-built equipment. On the sound-producing capacity of the equipment depends the price, and efficiency often governs the capacity of any unit. An inefficient layout therefore usually costs more than it should—if the contractor is fortunate enough to get the job.

The necessity for careful planning of an installation is well illustrated in the following example.

The requirements under this contract were a p-a. system to cover a new ball-park seating 35,000 people. As the park was also to be used as a football field, a second position was designated for the microphone, which therefore had to be movable. Both radio and phonograph had to be provided so that they could readily be controlled by the announcer.

The real problems of this installation were introduced by the fact that the speaker assembly had to be mounted at a considerable distance from the announcing points—raising questions of voltage drop and efficient impedance relations.

As the sketch-plan, Fig. 1, shows, the speakers were to be mounted on the 120-foot lighting tower. As it was proposed to use a certain make of horns, these were drawn to scale on the park elevation and plan blueprints. Accurate projection of the sound beams, both horizontally and vertically, showed that the most efficient height for these horns was a little over 65-feet, and that six of them would be required to give the necessary spread.

The next problem was to decide on the most efficient arrangement of the amplifiers. It was determined that the utmost in flexibility could be secured—allowing for future expansion—by using one PAM-5a voltage amplifier (consisting of a type -27 tube working into a pair of -45's) feeding three PAM-25a power amplifiers (two -27's and two -50's, both push-pull). These three output stages would each work into two dynamic speakers, allowing about 75 watts undistorted output per speaker.

A controlling factor, however, was the long run of the voice lines from the microphone. Naturally, the two-stage microphone amplifier had to be located close to the microphone, as the distance from the mike to the speakers was either 800 or 1100 feet, dependent on whether the game was baseball or football. After due consideration, it was decided to use a 60-ohm line between the mike amplifier and the voltage amplifier, and to locate the latter as near the speakers as possible. Low capacity lead-sheathed twin cable was adopted throughout, having a d-c. resistance of about 5 ohms per 1000 ft. The final arrangement therefore was to house the main amplifiers in the base of the lighting tower—for which purpose a room was built—and to work direct from the amplifiers into the speaker voice coils. This of course necessitated using out-

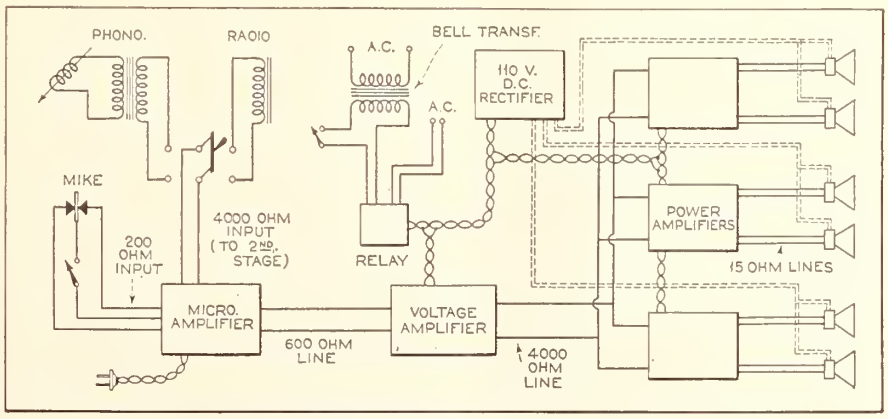


Fig. 3. Amplifier layout.

put transformers having two 15-ohm windings, or rather, less.

This arrangement resulted in the use of six separate pairs from the amplifiers to the speakers. This was considered a better arrangement than putting the voice coils in series, as in case of breakdown each line could then be checked separately.

A refinement introduced here was the installation of an impedance plug panel which enabled each voice coil circuit to be opened and an impedance of equal value substituted in the feed line, by means of an ordinary plug. Thus, should a voice coil burn out, it could readily be detected and the impedance substituted. The length of the 15-ohm lines, it will be noted was but 60-feet.

In order to minimize the possibility of having to service the speakers on the mast, the standard dry rectifiers were removed and the fields supplied from a tube-type rectifier assembly in the amplifier room, using pairs of type -81 tubes for full-wave rectification.

Announcing Equipment

As the microphone assembly had to be portable, it was necessary to house the mike amplifier in a suitable carrying box, with plug receptacles for the phonograph and radio, and a simple switching arrangement. All that the announcer had to do then was to detach his a-c. and line cords. A special small bakelite panel was built into the end of this box to carry the switches, and indicator lights were provided to show what was "on" and what was "off." A switch on the plug panel in the press box where the announcing was done, cut out the dead end of the line when the remote position was not in use.

On the same panel was incorporated a momentary-contact switch which operated a relay in the amplifier room and threw the a-c. "on" or "off." With this arrangement, the announcer could operate the entire system from the press box or the football announcing booth, and it was unnecessary to enter the amplifier hut.

In distinct contrast to this job as to the problems involved, was a small ship installation. This installation, which was duplicated on another boat, consisted of four dynamic speakers built into the panelling of three public rooms—the smoke-room, observation room, and dining saloon. Music is provided by a phonograph and radio receiver, with centralized control of volume. The receiver used is the latest type superheterodyne having a pair of —45 tubes in the output stage. This, of course, was not quite sufficient output for the four speakers, giving but a little over 1 watt per speaker. A separate output stage of push-pull —50's therefore was built up in this installation from AmerTran parts, with its own power supply. It was considered quite unnecessary to go to the trouble of altering the —45 stage to —27's as there was ample gain in the —45 stage to produce maximum grid swing on the —50's.

As the ship's supply was 115-v. d-c., a converter was supplied to transform this into 110-v. a-c. Some temporary difficulty was experienced with this 350-watt converter due to the hum of the armature. The converter was installed in the engine room, yet the faint whine was audible two decks above at the radio input. Mounting the converter on springs eliminated this, while the abolition of the frame ground also helped.

All speaker fields, which were designed for 100-v. d-c., were fed from the distribution box at the radio so that they were automatically switched off with the radio.

Multiple Speakers

Another minor problem that promised to give trouble was the method of splitting the output among the three speaker circuits, each being handled by a separate volume control. The first method tried was to insert an output amplifier having a separate secondary winding for each speaker circuit. This however did not give the quality desired. The arrangement finally adopted consisted of using the original speaker input transformers removed from the speakers and mounted on the amplifier. The quality was then excellent, regardless of the position of the various volume controls. Packard No. 77 cable was used for voice lines throughout.

▲

CAMERA SILENCING SUBCOMMITTEE PLANS FOR 1931

As a first step in the renewed investigation of the problem of silencing the camera, the committee is conducting a survey of the experiences and opinions of all first cameramen in Hollywood studios with regard to camera covers (blimps, bags, etc.). In this survey the committee is receiving the cooperation of officials of Local No. 659 (International Photographers of the Motion Picture Industries), of the I.A.T.S.E. and M.P.M.O. Leaders of the American Society of Cinematographers have also expressed approval of the survey.

The questions call particular attention to the effects of new developments in noiseless recording and directional microphone devices.

This survey is intended to keep the Producers-Technicians Committee of the Academy of Motion Picture Arts and Sciences, abreast of current developments and needs in camera silencing. In 1930 this subcommittee conducted a thorough survey of the problem followed by scientific noise tests of all varieties of camera covers and of the cameras themselves. It was found that the silencing efficiency of the device varied over a wide range, and that the range in noise from the uncovered camera was a very considerable factor in the problem. The published report of the subcommittee established standards for desired camera silence, listed fundamental requirements and recommended materials for camera covers. It is planned to bring this report up to date after the present investigation.

The camera silencing subcommittee consists of Kenneth F. Morgan, Frederick M. Sammis, and Lester Cowan, manager of the Academy Technical Bureau.

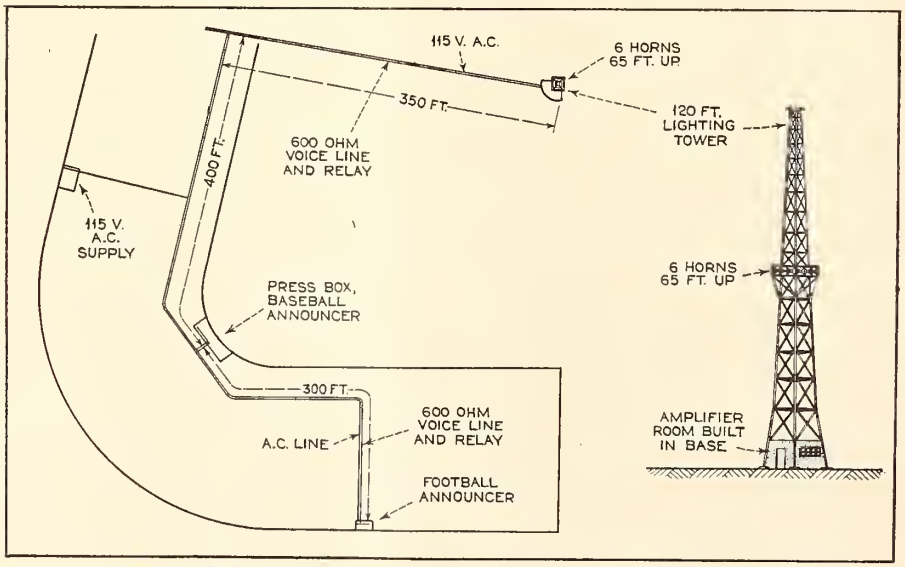


Fig. 2. Fig. 1.

Sound Disc Synchronization

By B. Brown, B. Sc.

Practical methods of quickly reestablishing synchronous operation of sound and picture in projection equipment

THE greatest disadvantage associated with the use of the disc record is undoubtedly the possibility of losing synchronism between the picture and sound. Even the most hardened projectionist feels a shudder go down his spine when picture and voice by some means or other manage to get out of phase.

Some of the smaller types of sound equipment were so designed that it was possible to regain synchronism once lost by speeding up either the head mechanism or the turntable drive. In the larger and more popular systems, however, no such mechanism exists probably because it would be capable of abuse. As a matter of fact the idea of regaining lost synchronism is one of the oldest associated with talkie picture science. Gaumont in some of his early experiments incorporated a sort of differential drive by means of which the projector could be brought into line with the turntable by means of an extra electric motor which, as soon as it had accomplished its object, was cut out of circuit.

What is to be done if synchronism is lost on one of the inflexible types of mechanism? We refer of course to those cases where either the needle jumps a number of grooves or the film breaks above the intermittent sprocket. A breakage below the sprocket is of course of no importance since the relationship between picture and portion of sound groove still remains the same.

In most of the instruction books on the subject it is stated more or less definitely that when synchronism is lost as described above it is useless to endeavor to regain it. In practice, however, this is by no means true as we shall endeavor to show in the following notes.

Let us first examine the different means by which we may lose synchronism:

(1) The needle may jump a groove due to an excessively recorded passage which usually occurs in the lower frequencies.

(2) The needle may jump from the start mark to the first groove if the projectionist has not gone to the trouble of pulling the machine round for the better part of a revolution prior to switching on the motor.

(3) Either the pickup or turntable may have been jogged causing the needle to jump.

(4) A needle not properly clamped in its holder may vibrate strongly causing a jump.

(5) A worn or low grade needle may have the same effect.

(6) A warped disc acts much after the same style as the previous causes.

(7) A film may break above the intermittent sprocket—this is by far the worst case.

Recording on disc is a well-established art and is probably nearing the limit of its efficiency. With the advent of talking pictures, however, fresh factors added themselves to its limitation. In ordinary commercial recording of the domestic phonograph record one of the prime considerations is to make sure that the record will have a sufficiently long life. It is more or less essential for a disc to withstand at least one hundred playings without deteriorating to such an extent that the reproduction becomes poor.

For sound motion pictures, this consideration did not weigh greatly since the life of twenty playings was all that was required for the standard running theatres. This gave greater latitude to the recording engineers who, we fear, allowed the amplitude of the grooves sometimes to exceed the danger point.

Needle Pressure

Projectionists will have often noted that in heavy base passages the reproducer or pickup is seen visibly to quiver and careful men often place a finger on the arm to reduce the chances of jumping a groove. It does not appear to have been fully appreciated by manufacturers of disc equipment that needle point pressure might have been increased to an extent at least 30 per cent greater than is the rule at the present time. This would undoubtedly tend to reduce the life of the disc itself, but as we have just mentioned, most discs are scrapped long before they show marked signs of deterioration.

The second cause of losing synchronism is really inexcusable. The rapid lead out spiral is sufficiently acute to apply enough momentum to the pickup to cause it to over-shoot the standard spiral grooves when it blends in with them. Always it should be taken as a rule that the turntable should be pulled round for at least half a revolution after the needle has been set to start mark with the initial film rack in the gate. Naturally some systems are more prone to give trouble in this direction than others. The repulsion type motor with electrical speed control rarely gives cause for trouble in this respect even when abused. Nevertheless even with such a smooth and slow takeup it is quite possible to have needle jumping especially if the head is a free running one and the weather warm when the bearing lubricants are lowest in viscosity.

Turntable Protection

Great care should always be exercised when passing round or near the turntable and reproducer arm. Most systems are fitted with guard rails or sunken turntables to act as a protection against jogging of any description. Nevertheless one cannot help but think that there is much room for improvement in this matter. A guard rail at the best of times is a poor way out of the difficulty and gives one the impression of being an afterthought rather than a definitely designed piece of mechanism. One of the best examples of turntable protection is to be seen in the Motiograph de Luxe Sound Projector of the Enterprise Optical Manufacturing Company. The turntable besides being sunk is given a further protection by being drawn partly beneath the lamp house carrying bracket which rapidly reminds the unwary one that he is nearing the danger zone.

That a loose needle should cause loss of synchronism appears a somewhat fatuous remark. This is not the case,

however, since as projectionists have found to their sorrow too strenuous application on the needle clamping screw is capable of throwing a pickup out of adjustment. This applies particularly to the rubber damped armature types although if too great force be expended on the disc diaphragm of the 4a reproducer the diagonal bar may easily be loosened causing a fall off in reproduction quality quite as bad as that of an out-of-tune armature pattern.

Clamping a needle in a holder sufficiently tight to give maximum reproduction and yet refraining from overstraining the pickup mechanism is something of an art in itself especially as no two projectionists have fingers equally sensitive. It is well worthwhile making an experiment on needle tightness. Take one of the ordinary loud tone type of "talkie needles" and clamp it in the holder just sufficiently tight to prevent its moving. Now try out a disc with which you are familiar noting at the same time the fader or potentiometer setting to give a certain degree of volume. Next, lift the pickup from the disc, tighten the screw hard down and play over again. It will usually be found that an increase in loudness corresponding to two fader steps will have been achieved.

Poor Quality Needles

The use of a poor quality needle is to be condemned from every aspect since it gives neither reasonable reproduction nor saves any money in the long run. The manufacture of phonograph needles has been delevoped by many years of experience and scientific research. As is commonly known the point pressure is exceedingly high especially at the start when it is sometimes well over two tons to the square inch. If the steel be not exactly to specification or the heat treatment wide of the mark the three thousandths diameter point will break down under its load giving a somewhat hooked form which besides carrying away the tiny harmonic curves tends to slide from one groove to another over the dividing wall.

When 16 inch discs were first released they possessed considerable bulk and carried recording on one side only. Nowadays, however, economy has become essential and thus the thickness of the disc has been cut down and one finds recording on both sides. While from the point of view of keeping costs within reasonable limits this is much to be admired, yet at the same time there is an increased tendency to warping especially during the hot weather. The backstock from which most records are moulded becomes slightly plastic at the temperature of a hot day and thus if the disc itself be stored in an upright position warping is almost certain to occur. For this the pressing firm is usually blamed but their task is by no means an easy one. Generally speaking, it is wrong handling of records which causes warping rather than imperfections in manufacturing processes. Always discs should be stored absolutely flat and in a cool place.

While in only very bad cases is warping sufficient to cause actual needle damage, yet even the slightest amount out of true will tend to mar reproduction by varying the effective pressure between needle point and bottom of the recording groove.

Another fault which may be safely laid at the door of the pressing companies is the eccentricity of the recording circle to the hole in the middle. A little consideration will show that a very few thousandths of an inch out of center will produce quite a high force causing the needle to be thrown strongly against the outer wall once per revolution. It has been suggested that some sort of taper device should be employed for locating the disc exactly upon the center spiggot. This would, however, be likely to induce considerable manufacturing difficulty and at the same time increase the possibility of disc fracture. A far more important point would be for pressing companies to devote more care to centering the hole in relation to the recording circles.

TABLE I

Revolutions of Turntable	Film Footage
(*pitch* = 100 *grooves per inch*)	
10	27
20	54
30	81
40	108
50	135
60	162
70	189
80	216
90	243
100	270
And so on in steps of 27 film feet	
250	675
260	702
270	729

Film Breakage

Film breakage is nothing like so prevalent nowadays as it was, say four years back. However, statistics of this nature do not help a projectionist when he finds that the key reel has broken off above the intermittent. It is all very well tabulating the various directions which should be taken to avoid trouble of this nature, but the fact remains that it does occur on occasion even in the best of projection rooms.

When a needle jumps the dividing walls between the grooves acting on its volition rather than the combination of circumstances which go to make up this action, in nine cases out of ten it jumps one dividing wall only and thus is either one revolution in front or behind the corresponding picture. Further consideration of this makes it evident that when synchronism is lost in this manner it is lost by one or more complete revolutions of the turntable. Since most reproducers are set with a slight outward drift the probability is that the needle will jump from an inner groove to an outer rather than vice-versa although this is not always the case.

Sound in Advance

Supposing the sound suddenly becomes slightly in advance of the picture then an attempt at remedy may be made by stopping the projector after bringing the fader to zero and carefully lifting the needle point from the groove in which it rests to the next one inwards. In most cases of loss of synchronism this will be found effective and the only query in the mind of the projectionist is his ability to lift the needle from one small groove to another without missing one or two in the process. The approximate pitch of grooves is ten thousandths of an inch. It is quite possible with a little care and proper illumination to remove a needle from one groove to another or for that matter to any predetermined number. The writer knows of one projectionist who has fitted a small lens to a hand flashlamp which he uses for this purpose.

The same object may be accomplished in a different manner by stopping the machine and gently turning the disc backwards for one complete revolution while the turntable itself remains stationary. The little cam trigger on the center spindle may be turned round so that it points directly to start mark and this serves as an efficient indicator. While it is quite an easy matter to turn the disc an extra revolution round in the correct manner it requires much more gentle operation to rotate it in the reverse direction since this is against the 60° slope of the needle. Nevertheless it presents no practical difficulties to a careful hand.

Regaining Synchronism

The most drastic method of regaining synchronism after the style mentioned above is to make the alteration while the projector is running at full pace. Thus, if the sound gets in advance of the picture the clamping cap of the turntable is first raised and twisted so that the trigger points to start mark. The thumb is then applied to the edge of this disc just as start mark passes the hand. This stops the rotation of the disc entirely and when the turntable

has completed another revolution as indicated by the trigger, the pressure is released thus allowing disc and turntable again to rotate as a whole. Naturally the sound in the auditorium is affected but since the whole operation takes place in two seconds there is nothing very much to worry about.

When for some unknown reason sound gets behind picture the problem is distinctly more difficult. It is necessary to pull round the disc for one revolution in advance of the turntable while the latter is revolving at its normal pace. It will be found that simple thumb-pressure on the edge, while sufficient to move the disc, is not a convenient method of drawing it round quickly into the desired position. The best way is to moisten the fingers and draw them quickly and firmly across the top surface of the disc thus pulling it round as required. Before doing this a certain amount of drag should be applied to the edge of the turntable so as to draw the damping mechanism taut which otherwise would produce a bad wobble of the reproducer while this was taking place. The whole of the operation is of a distinctly finicky nature and requires skill and steady nerve but if carried out well is probably better than stopping the show for a minute or so while the needle is lifted from one groove to another.

If the Needle Jumps

The above notes cater for reasons given under numbers (1) (2), (5), and (6) providing the needle has jumped only a single groove. If the removal from one groove to the next does not effect complete synchronization another move to the next groove should be carried out in the same manner. It takes a long while to describe but the expert projectionist will not occupy more than thirty seconds in the action, from start to finish. Film breakage, jogging the reproducer arm, and a loose needle may be classed within the same category since that usually means that the needle finds a resting place in any but the correct spot. Can synchronism once lost in this manner be regained? The mathematical problem of locating any one particular place on a very long spiral together with a corresponding spot on an equally long film appears a very difficult one. As a matter of fact, however, it is considerably simpler than would be supposed from first considerations. We do not definitely require to locate *any* point of disc with its corresponding point of film. All we wish to do is to be able to re-synchronize both elements at any known place on the one or the other and reasonably close to the place where trouble occurred. While positions on the disc are not located by any numerical values, each foot of synchronized film is given a number starting at the beginning. Thus, if the film breaks off say at 50 feet and 3 inches it would be quite satisfactory to regain synchronism at say 60 feet. The 10 feet of film lost would naturally not be serious since it represents something less than 7 seconds of entertainment.

Pitch Must Be Known

It is actually possible to regain synchronism at any part of a properly made film providing the pitch of the record grooves is definitely known. We used to believe that disc recording was carried out at a uniform pitch of 100 grooves to the inch. Now, however, we are wiser and find that they may vary from round about 80 to 110. The standard pitches adopted by the Western Electric Company are 86, 92, and 98 grooves per inch. These rather "odd" numbers are not adopted through sheer "cussedness" but owing to the most convenient gear ratios employed between turntable drive and cross-feed.

While it is doubtful whether the following method is sufficiently practicable to be adopted in every day use, nevertheless it is of some interest and has been carried out satisfactorily in quite a number of cases known to the writer.

Briefly the idea is as follows: Since the turntable rotates at 33⅓ revolutions per minute its value corresponds to 1½ feet of film per second, and the first problem is to find the highest common factor of these two quantities which works out to be 90 feet. Thus one revolution of the turntable corresponds to 2.7 feet of film, two revolutions to 5.4 feet and so on. It is thus possible to correlate each revolution of the turntable with a definite position on the film which may be determined by reference to the marking numbers on the edge. Table I provides the film numbering which corresponds to complete revolutions of the turntable. Now suppose the film broke at 680 footage then referring to the table the next highest number about this is 702 feet which would then be set in the film gate as the new start mark. Referring again to the table we find that this value corresponds to 260 revolutions of the turntable which if the pitch were the normal 100 to the inch would be equivalent to 2.600 inches. A needle pointed vernier would then be set to this value less .09 inches which corresponds to the distance between the start mark and the first groove. Applying one end of the needle point to the sound groove opposite the start mark and the other end diagonally across the record the new position for the reproducer needle can be found.

Standardized Grooves

As a matter of fact although the method appears complicated it can be reduced to reasonable simplicity by a specially calibrated vernier which might well have found a place on the market if pitch grooves were standardized. However, the present regime of varying pitches renders it a problem scarcely worth the trouble involved which may be remedied when the new type of 12 inch disc becomes the rule with its lower recording amplitude.

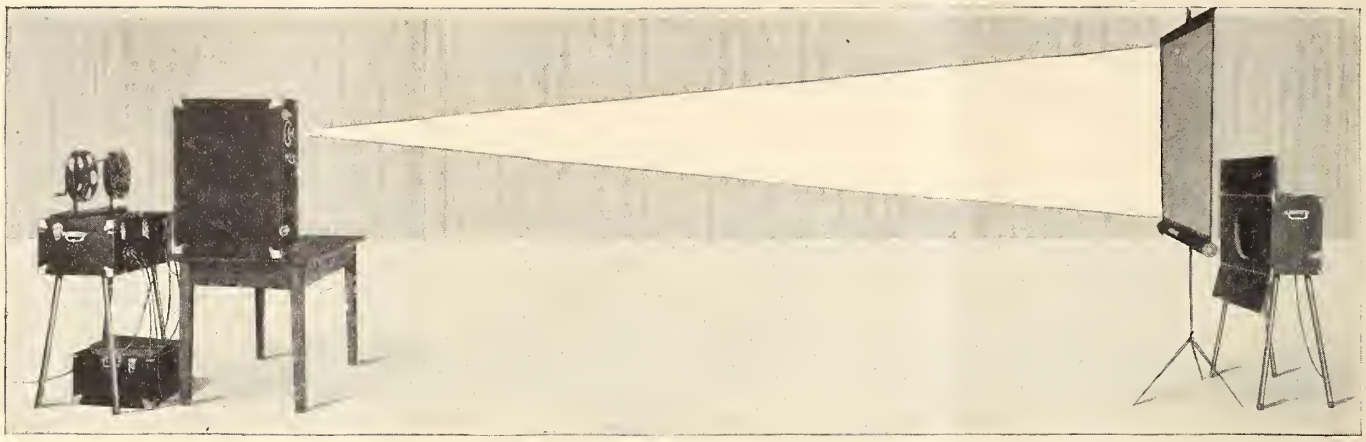
In conclusion, a few words may be said as to the best procedure to adopt when synchronism has been lost and cannot be regained by any quick method. The alternatives are of course to run on silent, to cut the particular reel, or stop the programme, mend and re-wind. As to which is the best to adopt depends entirely upon circumstances, although the worst possible thing is to run a sound picture without its sound. If the reel is unimportant and may be cut out this method involves the least trouble and probably the greatest satisfaction to all concerned. A vital reel, however, containing the keynote of the story cannot be scrapped without annoyance to the audience. Splicing synchronized disc film is by no means a pleasant task even at the

(*Concluded on page* 18)

EXHIBIT OF NEW APPARATUS TO FEATURE S.M.P.E. SPRING MEETING

One of the features of the spring meeting of the SMPE to be held in Los Angeles, May 25–28, will be an exhibit of new motion picture equipment developed within the last year, according to announcements by the program committee. The board of governors has also announced that the convention will be extended over a period of five days to permit ample time to visit studios and all other points of interest.

The equipment exhibit will not be in the nature of a trade exhibit since there will be no booths for exhibits, although definite free space will be allotted to each exhibitor. Rules regulating the exhibits require that the equipment be new or developed within the last twelve months; no pamphlets or advertising literature will be permitted. Each exhibitor will be permitted to display one small card giving the name of the manufacturing concern and each equipment shall be labeled with a plain label free from the name of the manufacturer. A technical expert capable of explaining the technical features of the apparatus will be required to be present during the exhibition. All exhibition space will be furnished gratis and the apparatus to be exhibited will be censored by the apparatus exhibits committee.



Projector with screen and loudspeaker.

Talking Picture Equipment for Portable Use

By John Dunsheath

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Description of a Practical and Simple Portable Projection Equipment for Portable Service

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THE success of and public demand for the talkie screen is today attracting the attention of every type of industry. Steamship companies find it necessary to entertain their passengers at sea with talking pictures. Colleges, schools, clinics and other educational institutions find a great asset in the talkies for their educational value. State hospitals, sanitariums and even penal institutions find much good use in this new industry. Clubs and other fraternal organizations are feeling the necessity of talking pictures to complete their amusement facilities. Many hotels are finding an asset in providing talkie equipment in one of their show or sample rooms. Some have already gone so far as to provide complete projection rooms for the showing of advertising films, etc. Large automobile and other manufacturers are producing talkie film advertising and sales campaigns. A hotel having the equipment can accommodate the officials of such firms and provide a means of showing films at the same time. Local clubs and orders may rent the rooms having such equipment at an attractive non-competitive price.

But what are the requirements for this field?

This equipment must be: (1) Very dependable and give a high quality of reproduction; (2) as fire-proof and as safe as human ingenuity can make it; (3) the price must be within the range of the field; (4) the equipment must not require too much space and must be readily portable; and, (5) the operation of the equipment must be simple and fool-proof, the construction rugged to withstand being transported.

After a thorough analysis of the field and as a result of much research, the equipment described in this article was designed to meet the requirements set forth above. This equipment passed severe tests covering a period of eighteen months before it was released to the public.

To make the equipment of extraordinary safety to the audience and the property, this projector is provided with several novel and simple automatic devices.

The film runs over an idler roller which is connected to an automatic circuit-breaker. Under normal operating conditions, with the film in the projector, this idler holds the motor and lamp circuit "closed." The automatic dowser, or fire-shutter, is also connected to a circuit-breaker which controls only the lamp circuit by means of a governor.

If film is in the machine and the lamp switch is turned to the "on" position, the lamp will not light until the projector has attained full speed, at which time the governor moves the dowser out of the path of the light and turns the switch to the "on" position. With this arrangement if the film runs out or breaks, the lamp and motor circuits are instantly broken and the entire unit is stopped. This eliminates fire hazards due to film breakage.

Air Cooled

In addition to the foregoing feature, a rear projection shutter is used and reduces the heat on the film by 40 per cent. The aperture and heat plate assembly is air-cooled by forced draft and is kept at a very low temperature—never being more than lukewarm. This reduces damage to film from over-heating and drying out. This item is of great importance in the non-theatrical field because in many cases valuable scientific or educational subjects are shown, and the wear and tear is an item of much concern. In the theatrical field wear and tear is ignored almost completely because the subjects lose their box-office attraction before the films are worn out. Educational subjects never lose their value and are preserved for indefinite use.

With the foregoing in mind a search was made for a smooth, easy movement—one that would be wear-proof and easy on the film.

The continuous rotary movement which is described herein was selected for this purpose, after many exhaustive tests and a great deal of research work. It is the only movement yet designed which is of the continuous rotary type with all the advantages of the star and cam intermittent without its disadvantages of short life and delicate adjustment.

To be assured of perfect performance

these machines are designed with steel to micarta gears which are enclosed in a housing and run in a bath of oil—the practice used in the automobile industry today. This construction takes the lubricating problems out of the hands of the operator and provides sufficient lubrication for a period of four or five years. No other lubrication is required except for lubricating the motor which should be done once a year.

Fire Hazard Reduced

In order to further reduce fire hazards, the projector and film magazine have doors and the film is enclosed in that particular part of the device. The projector case is lined with asbestos and sheet steel to assure quiet operation and still further reduce fire hazards.

The lens is of very large diameter, 2 9/16 inches, giving a maximum of brilliance and definition to the screen. A triple belt drive is used as a quiet but positive power transmission, and all belts are adjusted by turning a screw on the exterior front of the projector. There are no idlers and the belts may be tightened while the projector is in operation. Any one belt will operate the machine; hence, the show will never be paralyzed by belt breakage. Only endless belts are used.

In the amateur field the operators need know very little of talkie principles to successfully operate this machine. To further facilitate this, the amplification was developed entirely separate from the projector—not a single sound or speech wire is connected to the machine. The photo-electric cell and amplifier are contained in a separate case which is placed in a position adjacent to the projector.

The amplifier case is placed so that the light from the sound image on the film, and which comes from an opening in the side of the projector case, will fall upon the photocell. This amplifier is designed to accommodate two projectors, and, under these conditions, is located between them. This arrangement is shown in the illustration showing the tandem setup.

One of the purposes of this design is to occupy a minimum of floor space so that a very small booth can be used with comfort to the operator. This is accomplished by the use of a right and left projector designed especially to meet these requirements. In many places, such as on ocean liners, in schools, and clubs, a permanent or large unsightly booth is very undesirable, and in some cases practically impossible. This feature eliminates the necessity of a permanent booth. Another very important advantage of this design is that it permits of the use of very short leads from the photocell to the amplifier. This tends to increase the quality of the reproduction because the quality decreases in direct proportion to the increase of the length of these leads.

The projector

Two Models

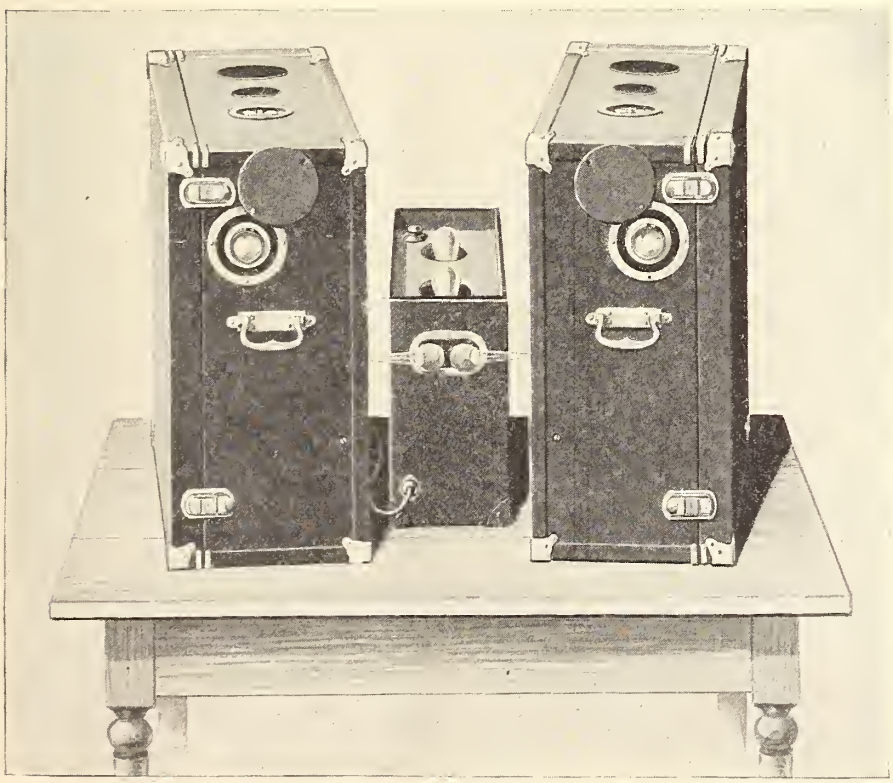
This equipment is available in two standard models: The DeLuxe and the Junior models. The DeLuxe model is designed for daily and heavy-duty work. Every shaft is of 3/8 inch diameter and is mounted on precision ball bearings. These are packed in grease and sealed. The main castings are of aluminum. The sound-head and the projection head are built into one unit, especially for sound-on-film reproduction.

By using special condensers and the unusually large lens the 1000-watt projection lamp is made a close competitor of the arc lamp and a clear picture can be had on a standard theatre-size screen at a distance of from 100 to 125 feet from the projector to the screen. The amplification can be used with regular theatre speakers to accommodate a large audience.

This model, complete with two projectors, rewind, cables, carrying-cases, accessories and all extra tubes, lenses, etc., weighs just 510 pounds. The heaviest case (the projector) weighs 113 pounds. All cases can be carried in the tonneau of a five-passenger automobile.

The Junior model is of the same rugged design and construction as the DeLuxe model and differs only in that plain bunting bronze bearings are used in lieu of ball bearings. The same gear construction and automatic lubrication is prevalent in the Junior, and a bath of

(*Continued on page* 20)



The tandem setup.

Film for Home Record Reproduction

By A. L. Walker

SINCE the commercial adoption of film recording for sound picture work there have been many attempts at utilizing the device in place of phonograph discs for ordinary sound reproduction. It now appears that these attempts have taken practicable form. The Austrian Selenophone Company well known for their full-size sound projection system which has attained a degree of popularity in Europe are now in process of manufacture of a home reproducing equipment which embodies sound-on-film recording.

For a long time the exponents of the disc have maintained that the high price of celluloid and the expense of photo-sound printing rendered popularity of this type of apparatus out of the question for many years to come. There was much to back this opinion and it seemed that the disc even while losing strength in the sound picture field would retain its position as a home entertainer.

The Selenophone Company, however, has proceeded along lines which are practical. They have abandoned the use of celluloid and instead print the sound tracks on a strip of paper, some ½ inch wide and cut to standard lengths of 300 meters. Another argument against the use of the sound track was that the size of a roll of film corresponded more or less to that of a disc record since the thickness of the film was roughly equal to the pitch of the sound grooves.

To combat this the Selenophone Company prints four sound tracks side by side on a single paper band thus quadrupling the time of play. On the standard projection speed a single 300 meter drum gives some 70 minutes performance, equivalent to about 10 double sided records.

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In Europe the Selenophone makes a bid to displace disc records.

Ink Printing

The expense of photo-printing has to a large extent been eliminated by an especially developed method of ink printing. The photographic impression of the original photographed sound track is first transferred to a metal plate and then to a "rubber blanket" which is used as a printing roll much after the style of the machinery used in turning out daily newspapers.

When one considers the difficulties which occur even in producing a good sound track the technical development necessary for placing ink printing on a commercial basis will be appreciated. Nevertheless there is positive evidence that sound reproduction from the Selenophone already reaches a quality not far less than the commercial disc with its many years of service. High frequencies are naturally the most difficult to reproduce since blurring during printing is bound to occur to a greater or lesser extent. It is stated, however, that this droop in the response curve may be adequately compensated for by the introduction of a response capacity input filter.

Variable Width Track

A preliminary consideration of the principles involved in this method indicates immediately that the variable width sound track must be adopted since it would be scarcely possible to reproduce variable density with its multitude of graduations.

Modulation of the photocell unit takes place by reflected light instead of transmitted, as in the case of the normal theatre projector. This involves a number of difficulties owing to straight light reflections but for the major part these have been overcome.

An interesting feature of the apparatus is that it employs a selenium cell of the well-known Thirring type. It would appear that the employment of this type of unit would be liable to accentuate the fall off in response at high frequencies. Nevertheless it will be fully appreciated that in view of recent developments the selenium cell is by no means dead even in the talking picture world and may easily find a new source of outlet in this rival of the electric phonograph.

The instrument itself already made into marketable form is not dissimilar in appearance to the ordinary phonograph although it incorporates two turntables or drums.

As soon as one length of sound track has been reproduced the relative positions of the light focus and tape are changed automatically and the drums are reversed in direction of rotation. This cycle is continued until four sound tracks have been completed.

Both Sides of Track May Be Used

A further advantage of the reflection method of modulation is that both sides of the track carrier may be employed if necessary. It is probable, however, that this last step on the path of economy would not be necessary owing to the cheapness of paper as a medium and the probability that extra expense would be involved in storage between the two printing processes.

While the fate of the Selenophone is still in the balance it seems a certainty that before much time has elapsed the disc record will have to suffer some radical if not revolutionary changes if it is to maintain its present popularity. After all, this is as it should be, for the disc has suffered very little advance for six years since the introduction of the electrical methods of recording.

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SPEECH AND MUSIC TRANSMITTED ON BEAM OF LIGHT

RADIO and recorded music from a standard radio-phonograph instrument was transformed into a beam of light, transmitted to another radio receiver at the other end of the auditorium and converted back into its original form, at a demonstration staged recently by Dr. V. K. Zworykin, research engineer of the RCA-Victor Company.

Following his lecture. Dr. Zworykin demonstrated the transmission of sound with a beam of light. Two standard Victor phonograph-radio instruments were used as the transmitting and receiving points, respectively. At the transmitting end, the radio was tuned in to a local radio station. The electrical impulses were passed through a transformer and converted into light by a neon lamp. The light from this lamp, focused by a lens, was then projected across the entire length of the auditorium to a mirror, which, in turn, reflected the light back across the room to the receiving end.

The Romance of Television

By L. C. Vipond

WHEN I began research on television I was considerably surprised at two things: The first was that the principles underlying seeing at a distance by electricity were known as far back as the early days of wireless telegraphy when radio telephony and radio broadcasting were unknown. The second was the eagerness with which experimenters and certain large corporations had taken up this new art in an effort to hurry it on to its ultimate practical success.

Now, two years later, it is more surprising to see the comparatively small progress that television has made when one considers the fanciful predictions that were made by the press and a number of scientists a few years back. However, there are various causes that are retarding television's progress.

Jules Verne, French author of many scientific romances, accurately predicted television as far back as 1870 in his famous "Twenty Thousand Leagues Under the Sea" which was written in that year. In that book he told how Captain Nemo, the mysterious owner of the great submarine, had worked out the scientific application of seeing at a distance.

Many decades have passed since the novelist's prophecy and during the intervening years, ambitious scientists and eager inventors have been striving to make television practicable. We realize now that radio television is an accomplished fact; from a dream it has become a reality. Television, like flying, had long been an enchanting hall in the dream-palaces of experimenters and inventors and it is difficult yet to realize the importance and full significance of such an epochal achievement.

In considering briefly the history of television it would be well to state that although its underlying principles were known to scientists many years ago, they were not applicable with the apparatus heretofore available. The main event leading to actual television was, of course, the transmission of photographs by telegraph and later by radio.

In 1925, there were several pioneers at work on the fascinating problem of transmitting photographs by wire and by radio. Of these pioneers, C. Francis Jenkins in Washington, D. C., was perhaps the most successful. Although demonstrated long before this as entirely possible, it remained for Jenkins to show that television could also be made commercially profitable.

It took five minutes or more to send one picture with Jenkins' early machine and in television at least eight or more images a second must be sent and received.

While radio-photography was being developed to a fairly high degree of perfection several other developments took place in 1926 that were to prove even greater strides toward useful television, the goal that all were seeking to attain.

The Photocell

One of the most difficult problems heretofore had been to produce a device that was sensitive enough to react to a shadow as the modern microphone responds to a whisper. The simple photoelectric cell had been in use for some time for the purpose of converting variations of light into variations of electric current. The cell used up to this time had proved too weak and its response to light changes too slow. V. K. Zworykin, a physicist of the Westinghouse laboratory, succeeded in combining the ordinary photoelectric cell with a special form of radio vacuum tube amplifier in a single instrument, producing an extremely sensitive "radio eye." This "eye" responded to light variations with the astonishing rapidity of over one hundred thousand times each second.

Brief Review of the Beginning and of the Present Status of Television Engineering

A short time after this, Jenkins demonstrated a machine for successfully sending faint silhouettes of moving objects by radio. This was made possible by using the newly perfected photoelectric cell in converting the highlights and shadows of objects into corresponding intensities of electric currents.

In December 1926, Dr. E. F. W. Alexanderson, consulting engineer of the General Electric Company and of the Radio Corporation of America publicly announced that he had accomplished the feat of seeing at a distance through the medium of electricity. However, the apparatus he used was somewhat unstable and also expensive.

In spite of the attempts made and partial successes attained, television, at the beginning of 1927, was still regarded as lacking in commercial possibilities. True it had been proved theoretically promising, but all of the systems that had been devised necessitated a costly outlay of apparatus and were also impractically delicate, complicated and in other respects unsatisfactory.

Telephone Engineers Contribute

Engineers in the Bell Telephone Laboratories have done much toward placing television on the plane it occupies today. It is stated that they were the first to make use of the neon glow tube and the scanning disc. This scanning disc is still the essential element in modern television transmitters and receivers and will continue to be until a better device is invented to take its place. Also, the Bell Laboratories' engineers discovered that a whole battery of large photoelectric cells could be used to pick up the light variations instead of depending upon one small cell. The resulting increase in response was tremendous as compared with any method previously used.

With the advent of the scanning disc and the neon tube a number of stations in the east began broadcasting television programs and hundreds of amateur experimenters began building receivers. All of this gave the new art the impetus it needed and at present several manufacturing companies have television receivers on the market.

Breaking up the Image

The underlying principles involved in television are comparatively simple and no doubt many students are familiar with them. The first essential of this remarkable development is the division of the image to be transmitted into a large number of separate units. No one has yet found a means for transmitting a picture as an entity. Sound is a linear quantity, having only length, and only linear quantities can as yet be transmitted. A picture has length and breadth so it is obvious that it must be broken up into successive sections before it can be transmitted.

The breaking-up process is accomplished by passing a powerful beam of light through a spiral of tiny holes perforated in a round disc. The rapidly turning disc is the scanning disc referred to and it guides the tiny shaft

Paper presented before the A. I. E. E. Branch, Louisville, Ky.

of light across the subject to be transmitted in a number of separate paths until the whole subject has been scanned. The spiral of holes is usually arranged so that the subject to be televised is scanned once with each revolution of the scanning disc. The swift, sweeping pencil of light casts reflections of varying intensities that are caught by sensitive photoelectric cells placed in front of the image, which change into electrical impulses whose strengths vary in exact accordance with the amount of light received. The principle of the photoelectric cell, of the "electric eye," is known to most students of electricity and with this knowledge the principles underlying television should prove surprisingly simple. It should be sufficient to say that after the light variations have been changed into electrical impulses, these impulses are amplified and transmitted by means of the conventional radio transmitter.

Of course the breaking-up process must be repeated a sufficient number of times each second to create the illusion of smooth action, just as in motion picture projection a certain number of images must be set up successively on the screen each second. In both cases the appearance of smooth action is obtained through that peculiarity of the human eye known as persistence of vision. In television the number of images sent each second depends upon the speed of the transmitter's scanning disc which, in most of the stations sending out television signals at present, is fixed at 900 revolutions per minute. This is 15 images each second.

The Neon Tube

At the receiving station the television signals are picked up by means of the the conventional radio tuner and after being greatly amplified the signals are translated back into light by a special lamp containing the rare gas neon. This lamp glows brightly or dimly in response to the varying incoming signals. The glow of the neon tube has no lag such as is found in filament lamps. The response of the neon tube is practically instantaneous.

After the signals have been received and changed back into light, the next step is to resolve these light variations into their proper positions in order to re-form the image, as presented before the transmitter. The scanning disc is again made use of and in this case it must have exactly the same number of holes around its outer rim as the disc used at the transmitting station.

It is obvious that to obtain any results at all the receiving disc must be rotated at exactly the same speed as the scanning disc at the transmitter. But even this synchronism of speed is not sufficient, the two discs must be rotating in exact step, or isochronism. This means that at the instant the shaft of light is passing through, say the twenty-fifth hole of the scanning disc at the transmitter, the light from the neon lamp at the receiver must also be shining through the twenty-fifth hole of its scanning disc.

It has been found a very difficult problem to obtain exact synchronism and isochronism in television, but recent developments and refinements have greatly helped along this line.

Increased Light for Scanning

In connection with television receivers there has been recently developed and demonstrated by the General Electric Company at Schenectady a receiver that does not make use of the neon tube to change the electrical impulses into variations of light. In a demonstration, this company made use of a projector having a high-frequency light valve controlling a local source of light. With this apparatus the engineers were able to use the incoming television signals to control the intensity of a powerful beam of light and thus project the images on a small screen. It had been impossible to project the images on a screen until then because the glow from a neon tube is comparatively weak.

This is admittedly a big step forward in advancing television from the "peep hole," limited to a single observer, to the screen, which a number of persons may view simultaneously, as in motion pictures. But the detail of the images sent and received in this demonstration remained unimproved and as a result of having been so greatly enlarged the images appearing on the screen were somewhat coarse and subject to the same limitations as before.

Evolution in any art is a slow process and the miraculous art of television, like the automobile and radio broadcasting, will gradually evolve into the perfected, product. Television is in its infancy. Its present stage of development is comparable to broadcasting in 1920 and 1921, before the boom in radio. While it may yet take many more years, television will be gradually simplified and improved until it will be universally adopted by the general public, to supplement radio receivers.

Television offers an interesting field for the experimenter and engineer. It is possible now for anyone with fair mechanical and electrical ability to fit a television receiver together. Into this fascinating art enters not only electricity, but much more in the realm of physics, as it deals with mechanical and optical, as well as with intricate electrical problems.

Leading scientists and engineers all over the world in most of the great laboratories have been working for many years on the problem of television and although progress does seem slow it is probable that we, who are accustomed to miracles, are too impatient.

Given sufficient time, I am convinced that civilization is about to reap the fruit of this latest achievement of science and this world of ours will shrink again. Not only will television entertain and be of service to the public, but in warfare it will be an invaluable instrument of offense and defense. Man in his onward progress has again reached out ond conquered, and his pace does not slacken as he passes on in search of new worlds to conquer.

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SOUND DISC SYNCHRONISM

(*Concluded from page* 13)

best of times and with the audience and the management waiting becomes something of an ordeal. It can, however, be carried out fairly quickly by an experienced man. When the joint has been made it will not be necessary to reproject the whole of the picture prior to the break. Probably the best way out of the difficulty is to run the machine on fast variable with arc light doused and stage horns cut off until the breakage point is neared. The speed is then reduced to regular and at the critical moment, the stage horn cut in and the douser opened.

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S M P E MAKES SPECIAL STUDIES OF PROJECTION PROBLEMS

THE Society of Motion Picture Engineers has begun a specialized study in all phases of motion picture projection and has appointed three separate committees to carry out the work.

The committees consist of the Projection Practice Committee, the Projection Theory Committee and the Projection Screens Committee, with H. Rubin, W. B. Rayton and S. K. Wolf acting as chairmen of each committee respectively.

The Projection Practice Committee is dealing with problems such as the ideal layout of the projection room and is collaborating with theatre architects to insure the most satisfactory location of the projection room. Other problems under investigation are projection room routine and maintenance, monitoring and control of sound in the theatre, improvements in projector design and accessories, film buckle, prevention of film mutilation, and fire prevention. The committee is composed of H. Rubin, chairman; T. Barrows, S. Glauber, J. H. Goldberg, C. Green, H. Griffin, J. Hopkins, R. H. McCullough, R. Miehling, M. Ruben, F. H. Richardson, H. B. Santee and P. A. McGuire.

Amplification in Sound Motion Picture Work

Part III

By Charles Felstead*

The Projectionist and the Engineer Will Find Here a Detailed Description of the Equipment Used in Present-Day Sound Amplifying Systems

CONTINUING the article on amplification begun in the February issue of Projection Engineering we may now consider the photoelectric cell.

The Photoelectric Cell

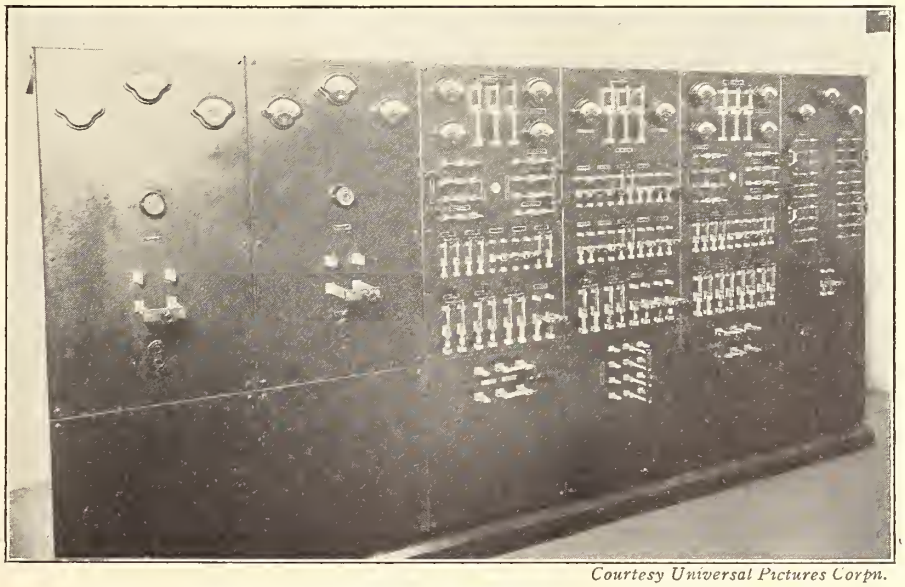
Inside of each film recording machine a photoelectric cell is mounted behind the moving film in line with the light beam that shines through the "light valve" and forms a narrow strip of varying exposure (the sound track) on the film. Through the action of this light valve, the beam of light is modulated by the amplified speech current produced in the microphone by sounds on the stage. After exposing a strip near the edge of the film in a degree directly proportional to the frequency and volume of the sound being picked up by the microphone, a portion of the light passes through the film and impinges on the sensitive surface of the photoelectric cell. Negative electrons are thrown out by the part of the sensitive photoelectric surface that is affected by the light, and the polarizing voltage that is applied to the PE cell causes these electrons to be drawn to the anode, thereby setting up a minute current flow in the PE cell circuit. This current flow is proportional to the quantity and intensity of the light falling on the photoelectric surface. Since the light is from an incandescent lamp of constant intensity, the current varies directly as the changes in the quantity of light that the moving ribbons of the light valve permit to pass.

The Photoelectric Cell Amplifier

This photoelectric cell is connected to the input of a special three-stage amplifier known as the PEC amplifier, that is mounted in a metal box just below the recording machine. The amplifier uses three small tubes of the "peanut" variety that are held in spring-suspended sockets, and has its own individual plate battery, which also supplies the polarizing voltage to the photoelectric cell. The variable rheostat filament switch, and filament ammeter are mounted on the panel that carries the controls for the recording machine. The outputs of the two PEC amplifiers in each recording channel are connected to the contacts of the PEC relay.

The monitor man normally leaves the two keys that control the relays in the off positions, and so he is monitoring directly from the bridging bus. However, it is compulsory that at least once during each "take" he turn on the key that causes the springs of the monitoring relay to be thrown from the direct to the PEC side, and then by means of the other relay alternately listen through the monitoring horns to the outputs of the two PEC amplifiers. That will assure him that the sound is actually being recorded on the film, and that no trouble has developed in the film recording circuit, such as a tube burning out or the strings of a light valve breaking.

There is a very considerable loss in electrical level from the bridging bus to the output of a PEC amplifier, and so, if there was no attenuation in the direct monitoring circuit, the output speech current from the PEC amplifiers, being of such a low electrical level, would not produce audible sounds in the monitor horns when the monitoring amplifier was adjusted to have the right amount of gain to operate from the bridging bus. The attenuator, which is similar to the ones used in the output circuits of the bridging amplifiers but which has a greater loss, is adjusted so that the speech current in its output is of the same level as the speech current in the outputs of the PEC amplifiers. It is only necessary then to raise the gain in the monitoring amplifier until the sounds created



Courtesy Universal Pictures Corpn.

Fig. 1. Battery and generator switchboard for a two-channel sound recording installation.

*Sound Engineer, Universal Pictures Corpn.

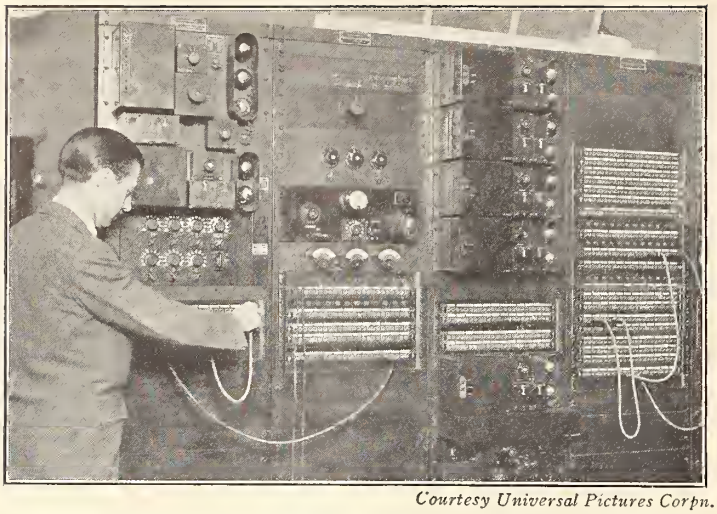


Fig. 2. Interconnection panels.

Courtesy Universal Pictures Corpn.

by the horns are of a volume that is satisfactory to the monitor man. When the levels are properly adjusted the only noticeable change in sound when the relay keys are turned to the on position is the addition of the "rush" noise produced in the PEC monitoring circuit by the passage of the film between the light source and the PE cell and the slight hiss that is inherent in these cells.

The Meters

In the center bay of each amplifier channel there is mounted a meter panel containing three meters for reading the filament and plate currents of the tubes in the amplifiers. Two of the meters are for checking plate currents; and the other is a filament ammeter. The high-range plate current meter is normally in circuit, but by means of a push-button, the low-reading meter can be connected in circuit when a tube drawing a low plate current is to be checked. Two-wire conductors connect the meters with special plugs that fit the filament and plate jacks in the amplifiers. The plugs are of two sizes so that there is no possibility that a plate meter will be plugged in the filament circuit of a tube and be burned out.

There is a complicated jack field in the center bay of each two channel installation, and there are also smaller jack fields in each amplifier bay. Practically every piece of apparatus in the recording installation has jacks connected in its input and output circuits. The jacks are hooked together through the terminal blocks in such a manner that the channel is in normal operating condition when there are no plugs in the jacks. When testing is being carried on or when unusual combinations of amplifiers are desired for special work, "patch cords" which are short lengths of two-conductor cord ending in plugs, are used for making connection between the jacks. The main jack field in the center bay is for the purpose of connecting the recording channels to sound stages other than the ones to which they are "normalled,"—each channel being normally connected to a certain sound stage when no plugs are in the jacks. This arrangement permits four recording channels to take care of as many as eight sound stages, because it is not usual that all of the stages would be needed for recording at any one time. Another advantage of this arrangement is that if a channel that is in use breaks down, another one can be substituted for it in a few seconds, thereby avoiding the expensive process of holding up a production company.

Distributing Frames

The main distributing frame, or MDF, which was mentioned in the first article, is composed of a metal framework on which are mounted a large number of terminal blocks. Intermediate distributing frames are installed in the monitor rooms and at strategic points in the recording building. Other terminal blocks are mounted at the bottoms of the amplifier bays and whenever bays and wherever several pieces of equipment are grouped together. All of the recording apparatus and the jacks are connected to terminals on these blocks, as are all incoming and outgoing circuits, and the circuits and apparatus are connected together in the proper manner by means of "cross connects," which are wire straps run between the terminals on the blocks. This arrangement makes it an easy matter to change the permanent connections of the apparatus when the necessity arises. An elaborate intercommunicating telephone and signal light system is also connected to these terminal blocks. The signal lights are arranged so that they indicate when channels and stages are busy, when multiple jacks are in use, and other things.

Battery Rack

Across one side of the amplifier room is a six-foot high battery switchboard. A multiplicity of fused knife switches, which are connected in each of the battery circuits in the installation, are mounted on this switchboard. There are also other switches for throwing the several sets of batteries from charge to discharge. Ammeters that read both charge and discharge are connected in all of the main battery circuits. High and low reading voltmeters are also mounted on the switchboard, as are the buttons that operate the starting relays for the battery charging generators. The batteries controlled by the switchboard are mounted in wooden racks in a battery room adjoining the amplifier room. Duplicate sets of all batteries are provided so that one set can be charging while the other set is in use. The batteries are of the storage type and are built in glass containers to permit the conditions of the plates and the amount of sediment in the bottom of the cells to be observed. The batteries that supply plate current to the tubes are about the size of the storage batteries used in automobiles; while the filament batteries and the batteries that supply current to the exciting lamps on the recording machines are much larger. Considerable care must be exercised to keep the batteries properly charged and to see that they are always clean and in proper operating condition. The supervision of the men who care for the batteries is one of the important duties of the engineer in charge of the amplifying equipment.

▲

TALKING PICTURE EQUIPMENT FOR PORTABLE USE

(*Concluded from page* 15)

oil is pouring over the bearings as long as the machine is in operation.

This model is especially useful for colleges and institutions where light weight is required and the duty is not of the "all day" kind. It is very convenient where it is desirable to give showings in different rooms or buildings or for the industrial advertising field.

Both of these models are of the overhead-loop or straight feed design. The overhead-loop machine has both reels on one common shaft in one magazine located within the projector case, while the straight feed design has both reels located in separate exterior magazines—one on top and one in front of the projector case.

Four-roller fire traps are used and all other possible requirements are incorporated in the design of both of these models for the purpose of meeting the laws of any state or country.

Filtered, oil-damped flywheeled sound shafts are used and each has a separate takeup sprocket to assure quality of reproduction of the most difficult numbers.

This equipment has been developed for and is sold exclusively by Bell Equipment Corporation, Suite 605, 729 Seventh Avenue, New York City.

Advances in Science†

By Dr. C. E. Kenneth Mees*

The Opportunities for Engineers, Physicists and Inventors Are Unlimited

THE fact that the world in which we live is changing at a very high rate is, I think, obvious and undisputed. Within our own lifetimes we have seen changes in method and technique which will affect the economic and social organization of society to as great an extent perhaps as the whole of the changes made from the Neolithic period to the beginning of the Twentieth Century.

At the present time, the rate of change is greater than any in the previous experience of man, and it appears to be still accelerating. The origin of this change is, of course, the development of our knowledge of nature, that knowledge which we classify under the general heading of "science." As long as our increase in the knowledge of science continues to accelerate, the resulting change in social and economic conditions will also accelerate.

At the present time, the proportion of human effort devoted to the acquisition of new scientific knowledge is increasing each year, but it is still only an infinitesimal part of the activities of mankind and only a very small part of the amount of energy which might be expended upon the development of science if that were generally thought to be worth while.

It has recently been estimated, for instance, that the industrial research laboratories in the United States are spending a sum of the order of $100,000,000 a year upon scientific research. It is certain that the universities are not spending as much; but if we include all available agencies, we might perhaps reach a total expenditure of $200,000,000 a year on the development of scientific knowledge and its direct applications.

Value of Research

It is estimated that during the last ten years the developments due to scientific research have increased the wealth of every family in the United States by more than 25 per cent ot their income, while the cost of research has been less than $10 per family per annum. It would, therefore, clearly not be impossible to increase our expenditure on research if it were necessary or desirable to do so.

A more immediate limitation to the development of science probably lies in the availability of men suitable for carrying on the work; but although the number of such men is certainly limited, and it would be difficult to increase the number very rapidly or to an extent comparable with the rate at which expenditure could be increased, there is still a very large number of men and women suitable for scientific work who for some reason or other are not engaged in it, so that the increase in the production of scientific knowledge is not likely to come to an end in the near future either for lack of funds or for lack of workers.

The production of scientific knowledge produces changes of great importance in our economic and social life, and the changes lag very much behind the production of science, so that as a general rule the science which is being applied today is not the science which is produced today but the science of which the fundamentals were discovered a number of years ago. As the rate of progress increases the period between a scientific discovery and its application diminishes, and, whereas it took us fifty years to apply Faraday's discovery of electromagnetic induction, such discoveries as the amplifier tube have been applied on a world-wide scale within two decades, and at the present time we may perhaps be considered as applying general and scientific discoveries of only ten years ago.

The much greater production of scientific knowledge at the present time, however, means that the application of science to industry and still more its effects on our economic and social life will continue to increase even if the amount of scientific discovery does not increase in the near future and there is every probability that that also will continue to increase.

No system which is changing at an increasing rate, and especially no system in which the product of the reaction increases the rate of change, can be stable. It is probably by analogy although it is not certain, that our present social system is in a completely unstable stage and that, after a period of violent change, it will settle into a new and stable phase which will endure until some new cause provokes another period of change.

This is what has happened in history before. After the great changes of the Twelfth Century B. C., the eastern world stabilized for a long period. After the fall of the Roman Empire, the world settled into the stagnation of the Middle Ages. After the changes of the Fifteenth Century, a new and comparatively stable system was developed throughout Europe, to be destroyed in its turn by the industrial revolution and the growth of modern science. What that stable system may be and how it can be stabilized, since we must assume that scientific discovery will continue, it is impossible for us to foresee, but it is certain that change can not continue at an ever increasing rate and that the end of revolution in any form is stability.

Energy of the Sun

The advance in our knowledge of the structure of matter has been of greatest value in connection with the light which it has thrown upon the production of energy by the sun and stars. It is generally held now that the source of the energy of the stars is the matter which they contain and that, either because of the form of that matter or because of the conditions in which it exists in the interior of the stars, it is being transformed into radiation, so that the sun is actually radiating its own substance out into space and is losing weight at the rate of four million tons per second—this prodigious amount, however, only reducing the weight of the sun by 1 per cent

† *Talk before the City Club, Rochester, N. Y., January 17, 1931.*

* *Director of Research, Eastman Kodak Company.*

in a hundred billion years. This has a direct relation to the future life of man, since it opens up vistas of new sources of power.

At the present time, engineering, which deals with the production and application of power, is utilizing the science of a hundred years ago. Most of our power comes from the burning of coal, the utilization of which in steam engines was related to the physics of the seventeenth and eighteenth centuries. The electrical engineer is utilizing the discoveries of Faraday and his fellow physicists of the early nineteenth century, and so far the discoveries of physics which correspond to what has been termed the "new era," the era of "atomic physics," have found very little utilization by the engineer. The airplane and the automobile depend upon the gas engine, and the general principles of the gas engine were well understood fifty years ago.

The Electron Tube

What are we likely to do when the new physics is applied? I doubt if any scientific man will dare prophesy in this field. The only thing that is certain is that there will be applications of the new physics in engineering and that these applications will open up entirely new vistas and be radically different from all previous experience. In one narrow field some of the work of the new physics has been applied.

The fact that a hot body gives off particles of electricity or that these electric units can be driven out of materials by the impact of light has produced the valve tubes and photo-electric cells which have enabled us to amplify electric currents and to transform light into electricity, so that there has been developed from these discoveries the great modern amusement industries depending on the production and amplification of sound. The radio and the talkies are a first earnest of what we may expect when the engineer is able to apply the physics of the twentieth century.

The greatest revolution which science could produce in human affairs would of course come from an entirely new source of power. At the present time man-produced power is very costly and we have to economize it to the greatest possible extent. We can not transmit it to long distances because to do so involves waste, and the natural order of things is that man always finds it necessary to avoid waste because his reserves are so limited, whereas in nature the waste is prodigious and the resources are unlimited.

In nature there are no efficiency engineers. If a factory were to start to produce fish, they would make tremendous efforts to ensure that a large proportion of all the fish started reached the eventual market. A loss of 20 per cent in the process of production would certainly grieve the engineers of the factory, but when nature produces fish, millions of eggs are laid, only a few thousand of which develop into fish at all, and only a few units into mature fish that can reproduce their kind.

Again, if an engineer had organized the solar system, he would presumably have tried to get a sun so arranged that its radiation was directed towards those of the planets that it was considered necessary to warm and that the remainder of its radiation would be conserved; but the actual sun which warms us so efficiently radiates its energy in every direction and wastes, if we may use the word, 2½ million times as much energy as falls on the planets.

The whole of nature is made on this plan. Almost all the matter in the universe is at a temperature quite unsuitable for life: probably nearly all the matter is far too hot, and practically all the rest is far too cold. The amount of matter in the whole universe which is at a temperature between the freezing and boiling points of water, in which range alone life as we know it is conceivable, is probably less compared with the matter in the universe than a single speck of dust compared with the earth.

Now, if we can tap the sources of power which are available in the stars and change the sun that warms us, then we can change our policy. If we could, for instance, break down matter and turn it into radiation, power would be available in limitless quantities, and we could afford to waste it as nature does. We could warm our homes and propel our vehicles and run our machinery by radiation of which only a small proportion achieves the end that we desire and most of which was thrown away as far as actual utilization is concerned.

At the present time the physicists give us very little encouragement in hoping for new sources of power. Nevertheless, it is incredible to me that sooner or later we shall not find some method of tapping the sources of power which are the ultimate sources of the universe. All the power we have comes eventually from the sun and must come from the breakdown of the atoms. It is incredible that we shall not sooner or later be able to produce that breakdown.

Turning from physics to chemistry, it seems certain that we can build up the whole reality of the carbon compound, starting with water, air and coal. The future supply of chemical materials for the human race, therefore, depends primarily upon the supply of coal, and while the quantity of those which can be used is limited, since the size of the earth itself is limited, it is very large. Nobody can make any accurate estimate of the time for which the coal supplies will last us, but it must be measured in hundreds of years if not in thousands, and to be concerned about the future supply of a material available for so long calls to one's mind the concern of the British people a little more than a hundred years ago when they were afraid that the oak necessary for the building of battleships would be exhausted. Until the exhaustion of a material is within one hundred years, it is unnecessary and often undesirable to be concerned about it. The probability is that, by the time the world is running out of its coal supply, some other source of power will have been found.

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Adding Loudspeakers and Film Sound Recording Systems are the titles of two of the technical articles to appear in the May issue of PROJECTION ENGINEERING.

AUDIO FREQUENCIES IN C.P.S.

Cycles per Second	
32,768	Beyond limit of audibility for average person.
16,384	Telephone silent with 40 volts on receiver terminals.
10,000	Considered ideal upper limit for perfect transmission of speech and music.
8,192	Highest note on fifteenth stop.
5,000	Considered as satisfactory upper limit for high quality transmission of speech and music.
4,096	Highest note on pianoforte.
2,560	Approximate resonant point of ear cavity.
3,072	
3,000	Considered as satisfactory upper limit for good quality transmission of speech.
2,048	
2,000	Maximum sensitivity of ear.
1,500	Mean speech frequency from articulation standpoint.
850	
800	Representative frequency telephone currents.
600	
426.66	Orchestra tuning.
256	
200	Considered as satisfactory lower limit for good quality transmission of speech.
128	
100	Considered as satisfactory lower limit of high quality transmission of speech and music.
80	Lower note of average man's voice.
64	Lowest note of 'cello.
60	
32	Lowest note of average church organ.
30	Considered ideal lower limit for perfect transmission of speech and music.
27	Lowest note of pianoforte.
25	
16	Lowest audible sound. Longest pipe in largest organ.

—B. S. Cohen, Proc., I. R. E., March, 1928.

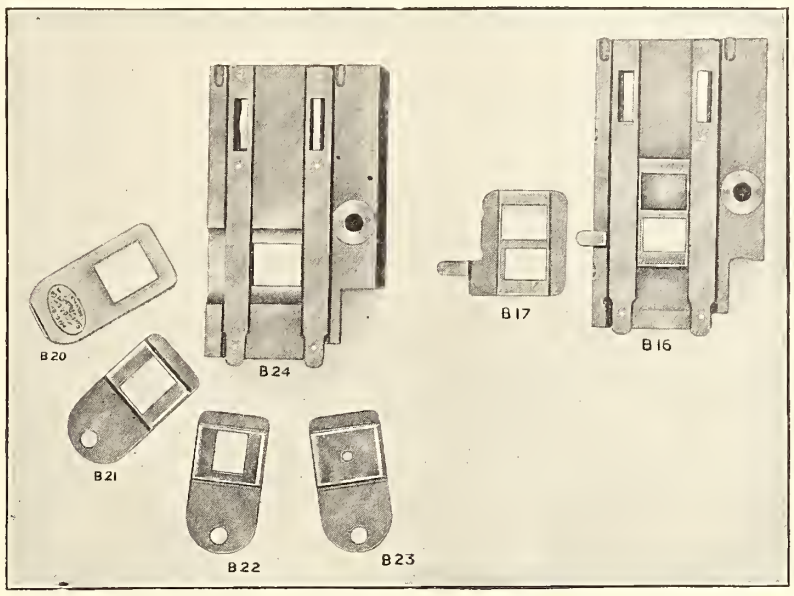
BLUE SEAL HEAT RESISTING IMPROVED FILM TRAPS

FOR SIMPLEX PROJECTORS

MADE OF AN IRON ALLOY

Guaranteed not to Warp under the intense heat of the Arc Spot. A necessity for the Perfect Projection of "Sound Pictures"

B-16 Film Traps with Sliding Double Round Corner Apertures, One Aperture for Disc and Silent Film and one cut Proportional for Movietone Film to be used with our Adaptors	$24.00
B-17 Sliding Double Aperture Plate.	6.00
B-24 Film Trap with individual mats for silent, movietone and magnascope effect. Traps complete with all mats	24.00
B-20 Master Plate to hold mats stationary	1.50
B-21 Standard Aperture with Square Corners	1.50
B-22 Proportional Movietone Aperture with Square Corners	1.50
B-23 Blank Mat (CAN BE CUT ANY SIZE APERTURE)	1.50



Both portable and permanent type

PORTABLE AND PERMANENT FIRE-PROOF PROJECTION ROOMS

STANDARD SIZES

4 ft. x 6 ft. x. 7 ft. 1½ in. high
6 ft. x 8 ft. x 7 ft. 1½ in. high
8 ft. x 9 ft. x 7 ft. 1½ in. high
9 ft. x 12 ft. x 7 ft. 1½ in. high
9 ft. x 14 ft. x 7 ft. 1½ in. high

THESE booths are made of 1/4" thick transite with angle iron 1 1/4" x 1 1/4" x 3/16". The panels are interchangeable and bolted together with stove bolts. The seams are filled with transite cement. The floor sheets are 3/8" thick asbestos. The Underwriters throughout the country have approved these booths, as well as the fire and building departments of all cities. Special booths built to conform with the Rules and Regulations of the Steamship Inspection Service on United States Shipping Lines.

BLUE SEAL PRODUCTS CO., Inc.

260 WYCKOFF ST. BROOKLYN, N. Y.

Distributor for Johns-Mansville Asbestos Products. Also Manufacturer of Motion Picture Accessories since 1913

WRITE FOR CATALOG OF BLUE SEAL PRODUCTS

New Developments and News of the Industry

FILM REELS

A new series of sound film reels is being marketed by the Universal Electric Welding Co.

These reels are spot welded, have no brazing screws, clamps or paint. Sizes vary from 16mm. to 70mm. in 1,000 and 2,000 foot capacities.

Aside from their rugged construction and light weight, the reels are designed to offer the least film friction, thus adding long life to the print by eliminating possibility of film damage.

▲

PRESTO RECORD MAKER

An entirely new conception of home entertainment, Presto Record Maker, makes records instantly, right in the home or office.

Attaches to any radio receiving set, thereby forming a combination for playing the record back as on a radio phonograph combination. One of the many features of this device is that it cuts and grooves its own records. It does not use pregrooved records.

With Presto, homes are transformed into recording studios. Permanent records can be made of baby's voice, personal expressions or musical and other offerings. Records can also be made direct from broadcast reception.

Presto uses smooth discs, 6 inch, 7½ inch, 10 inch and 12 inch in diameter. Records are made of aluminum alloy and are unbreakable.

▲

SYNCHROFILM IN PRINCESS THEATRE

Weber Syncrofilm sound-on-film equipment was chosen by the management of the Princess Theatre, 39th St., and Broadway, New York, after a thorough investigation of the independent field, and the results are up to standard in every respect. The job was done in record time, as the house closed its stage runs, with the picture booked less than a week later. The installation was supervised by J. A. Tannenbaum, Inc., eastern sales representatives for Weber Machine Corp.

A TRIPLE LENS TURRET

For Film, Disc and Magnascope

A new triple lens turret for motion picture projectors has been placed on the market.

This turret may be easily and quickly assembled to any Simplex projector mechanism. It will at once be apparent that by the use of this turret all projection problems affecting lens changes are eliminated. Each of the three lens mounts may be separately adjusted both vertically and laterally and each may be separately focused; also, these lens mounts accommodate all makes and focal lengths of lenses either half or quarter size. It is only necessary to insert, adjust and focus three lenses of the desired focal lengths after which any one of the three may be instantly swung onto the optical axis. One lens of the proper focal length may be used for silent or sound-on-disc prints, the second for sound-on-film, and the third for Magnascope or other types of effects. Where sound-on-disc is not in use, one of the lens mounts may be equipped for Magnascope, and another for some other particular effect, while the third remains for sound-on-film projection. It is obvious that any number of combinations of lenses may be used for different purposes and it becomes unnecessary to slip lenses in and out of the mounts during an entire performance.

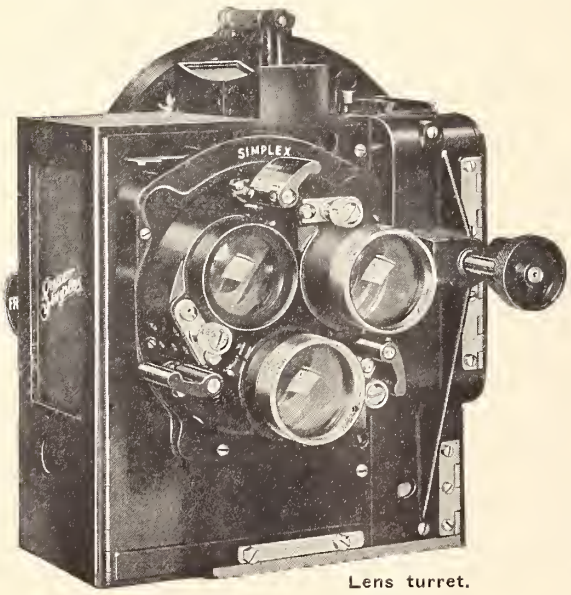
The turret proper is mounted in a substantial frame on four 90 degree V grooved rollers with provision for taking up all end and radial play in rollers, thereby providing a free-turning turret which is rigidly supported and free from shake and vibration. Positive audible stops have been provided for each projection position by means of index pins and a tapered lock so that normally but one lens at a time may be swung into position.

Due to the design of this unit none of the fire prevention devices have been removed from the mechanism and the fireproof properties of the projector have, therefore, in no way been impaired.

With the turret a new film protector and gate latch assembly are furnished, the use of which eliminates the necessity for the projectionist to place his hand within the mechanism when closing the gate while threading. The new lever release comes through the film protector and is very handily located. A slight pressure on the release button immediately closes the gate. A mirror arrangement is also provided on the rear of each lens chamber by means of which the aperture may be observed for checking up on framing after film is threaded in place.

No difficulty will be experienced in attaching it to the mechanism, and it is not necessary to cut away any part of the mechanism whatsoever.

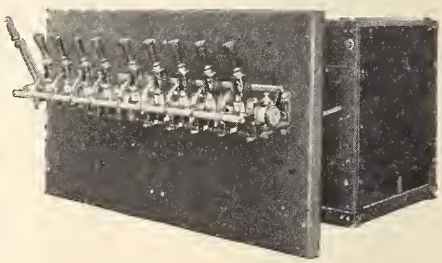
As stated, all half size lenses of standard dimensions may be readily inserted and clamped by the entire inside diameter of the mount. Where quarter size lenses are used it is necessary to use quarter size adapters.



Lens turret.

CUTLER HAMMER DIMMERS

The illustration herewith is of the Simplicity dimmer manufactured by the Cutler-Hammer Company, Milwaukee, Wis. The plates used in dimmer equipment may be arranged with the operating levers assembled either above the plates or below them.



In many installations the plates are located behind or away from the switch-board. The methods of mounting vary.

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OPERADIO MANUFACTURING COMPANY

The Operadio Manufacturing Company of St. Charles, Illinois, has opened offices and display rooms at 116 West 65th Street, New York City. This location is temporary until permanent location can be obtained.

Paul R. Fernald has been appointed manager of the New York office. He will have full charge of the sales for the New England territory as well as that of the New York. Mr. Fernald has been connected with the radio industry since its infancy, and is well known in the New York territory.

The Operadio Manufacturing Company, manufactures a comprehensive line of material for sound projection and speakers in all their branches, and is well equipped to supply the needs of the trade using these materials.

▲

RACON SUES MACY

The Racon Electric Company, Inc., has instituted suit in the U. S. District Court, Eastern District, against the Macy Manufacturing Company for manufacturing horns infringing on U. S. Patent No. 1,781,489, and has also instituted a separate suit against one of the latter Company's customers for using these infringing horns.

The Racon Electric Company, Inc., states that it intends to protect its patent rights, and will hold all infringers responsible for the use of infringing horns, whether they be manufacturers, jobbers, dealers, or users, such as individual theatres and dance halls.

▲

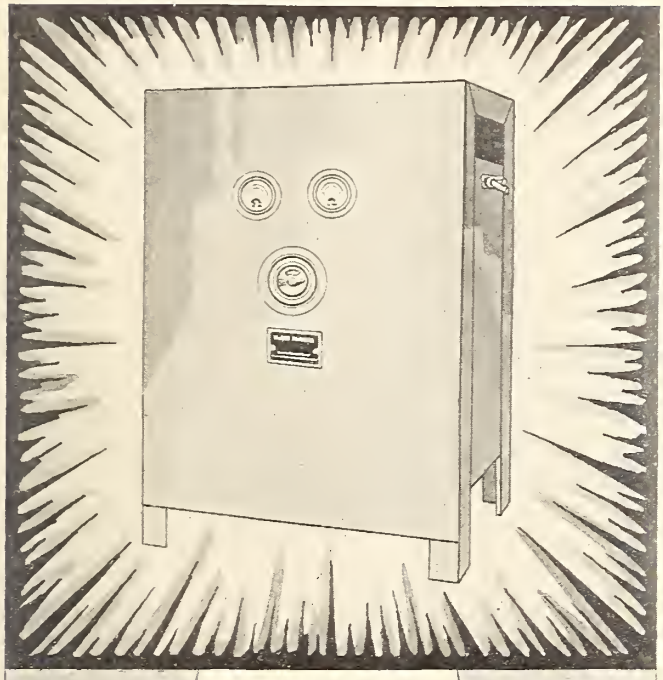
MAGNAVOX COMPANY

The Magnavox Company of Chicago advises that the settlement of the suit of that company against Frederick H. Thompson Company of San Francisco and the Grigsby-Grunow Company of Chicago.

The settlement made by the Grigsby-Grunow Company involves a substantial down payment, and a royalty on each and every dynamic loud speaker manufactured in future.

The company will shortly announce a new and improved loudspeaker for which patent applications have been filed.

FOREST
RECTIFIERS



FOR

GOOD PROJECTION

Forest Rectifiers are designed and constructed to meet the need for dependable rectification equipment. They are silent, and may be operated in the projection booth with sound apparatus.

The Forest M.P. 25-25 Rectifier, illustrated above, supplies steady, direct current of from 15 to 25 amperes to two projectors continuously.

All Types of Rectifiers in 15 amps., 25-25 amps., 30, and 65 amps., Sizes

Write Today for Literature!

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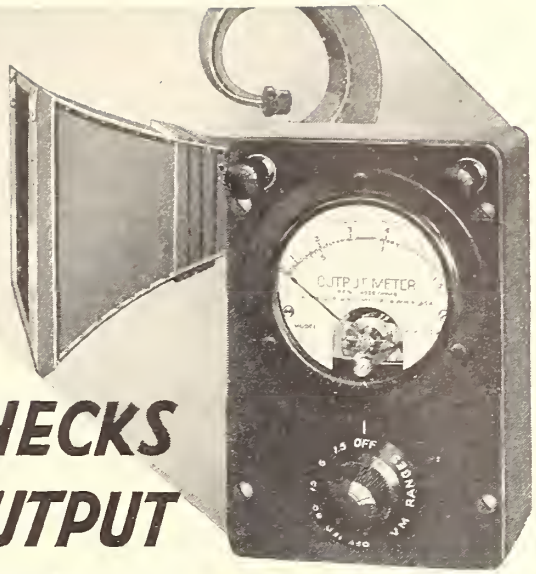

CHECKS OUTPUT of SOUND APPARATUS

WESTON *model* 571

The portable Model 571 OUTPUT METER is an invaluable instrument to projectionists for checking sound apparatus.

It measures directly the voltage output of the sound apparatus at speakers or at any other point in the circuit. It is exceptionally useful for checking the relative volume of speakers; for determining the relative gain of tubes and for determining fader settings.

The Weston OUTPUT Meter, when used in the projection room, provides a visual indication of the sound level in the auditorium. In this way, the correct volume of sound can be dependably predetermined for different capacity audiences from previous meter readings taken with audiences of various sizes.

This method eliminates guess work and furnishes immediate indication of the least perceptible variation of the output of the sound apparatus. Thus the change over to the reserve circuit may be made without annoyance to the audience.

These uses alone make Weston Model 571 OUTPUT METER invaluable to modern high-quality sound projection. This instrument is moderately priced and will pay for itself in a short time.

Model 571 consists of the Weston Model 301 A.C. Voltmeter of the Rectifier type with a constant impedance of 4,000 ohms. Its five ranges, 1.5/6/15/60/150 volts, selected by means of a dial switch, are brought out to two binding posts. The instrument is enclosed in a sturdy, black bakelite case. Size: 5½ x 3⅝ x 2⅛ inches. Weight: 1 pound, 10 ounces.

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608 Frelinghuysen Avenue Newark, N. J.

THE RECORDOGRAPH SOUND, DIRECTLY RECORDED

Important advance has been made in recent months in the development of simplified equipment for the direct recording of sounds for immediate reproduction.

Originally, tin foil was employed to receive the sound wave voice impressions. This was followed by wax cylinders. In recent months the process of recording has been improved so that now celluloid, gelatin and aluminum and its alloys serve this purpose to better advantage.

In playing back the record (reproducing the impressions) there is used a needle softer than the material of the record. This is so that the bulk of the wearing away will be on the replaceable needle. At present cactus fibre and bamboo are favored for needles.

In the process of recording a turntable is operated by a powerful motor, a feeding device to guide the cutting head in the conventional spiral form, an amplifier and associated speed and volume control. A playback arrangement can be mounted in the same cabinet, using the same turntable and motor for reproduction. The same amplifier is used. For the cutting head a loudspeaker is substituted, and for the pickup, a microphone. By the movement of a small switch an instantaneous changeover is effected from recording to playback.

These outfits are available in portable form and one model has associated with it a camera for making moving pictures simultaneously with the sound recordings.

An excellent type of recording and reproducing machine is the Recordograph manufactured by G. J. Badgley, 106 West 46th St., New York.

▲

AMERTRAN ANNOUNCES NEW SOUND SYSTEM PANELS

A new and complete line of AmerTran sound system panels has just been announced by the American Transformer Company, 178 Emmet Street, Newark, N. J. These panels are made for fourteen different applications and may be assembled in various combinations on standard mounting racks to make up complete sound systems for every conceivable requirement. The panels have been designed to permit extreme flexibility so that standard apparatus may be supplied promptly for every purpose and so that the equipment may be enlarged or reduced whenever new conditions make a change advisable, the latter being possible without loss of time and at a minimum of expense.

AmerTran panels are of rugged construction and have been designed to meet the most exacting requirements. In all cases the apparatus is mounted on solid aluminum panels of standard (19 inches) width but varying in height in 1¾ inch multiples, the edges being notched to facilitate assembly in the most convenient position on standard mounting racks. The fronts of the panels are scratched-brushed and clear lacquered, and dust covers are provided on the rear to protect apparatus and for the safety of the operator. Knockout boxes for BX wiring are also included on all dust covers to comply with Fire Underwriters' regulations.

▲

BEST CARBON SAVER

The Best Devices Co., 200 Film Building, Cleveland, Ohio, manufactures the carbon saver herewith illustrated. This permits the projectionist to get at least one more reel from each set of stubs. Made in 7, 8, 9, 10, 12 and 13 mm. sizes.

Best carbon saver.

ADVERTISING PROJECTOR

The new Auto Cinema sound-on-film advertising projector, product of the Auto Cinema Corporation in collaboration with RCA Photophone, Inc., was demonstrated before a group of representatives of motion picture trade and technical publications at the former corporation's offices in the General Motors building, No. 1775 Broadway on March 11, last.

Enclosed within an attractive cabinet which stands about five feet six inches high and which is approximately three feet square, the sound reproducing equipment, comprising the projector, amplifier, motor and six-inch loudspeaker, operates as a unit from power supplied from a lamp socket. The picture is projected upon a transparent screen eighteen by twenty-two inches in dimensions which is located at the top of the cabinet.

An outstanding feature of the apparatus is that the film may be projected indefinitely. This is made possible by means of an endless re-winding device upon which the Auto Cinema Corporation has been granted patent rights in the United States and Canada. At the demonstration a number of sound trailers and what might be classified as "short short" subjects were projected expressly for the purpose of emphasizing the importance of this feature in connection with the reproduction of trailers for current and forthcoming attractions in the lobbies of theatres or advertising subjects in hotels, railroad stations or other public places.

The sound attachment was developed in the engineering laboratories of RCA Photophone, Inc., to which the Auto Cinema Corporation had taken a model of a silent projector into which the endless rewinding feature had been fabricated. With the only difference being in the size of the objects upon the screen, both projection and sound compared favorably with the sound and projection obtained on standard size RCA Photophone reproducing equipment.

▲

VALLEN AUTOMATIC SCREEN MODIFIER

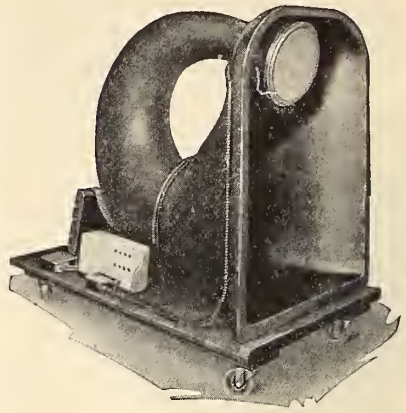
As its name implies, the modifier is used in connection with wide size films. E. J. Vallen devoted more than three years time to its perfection before announcing the device to the trade.

In construction it is extremely simple and exceptionally rigid. The steel framework is built like a skyscraper and is positively safe. This framework supports and contains all modifying apparatus.

The entire unit is electric motor driven, simply operated by a single button, push-button station, which provides instantaneous starting, stopping and reversing, and because of the remote control switch, can be controlled from the projection room. Quiet operating electric motors were specially designed for this application. Positive chain drive provides perfect synchronism and noiseless operation. The flameproof velour curtains move smoothly and evenly from the sides and top, contracting or expanding the screening surface at the will of the operator. A truss at the top and battons on either side, to which velour is securely fastened, assure an absolutely straight modifying edge line.

Vallen automatic screen modifier can be easily installed without changes or alterations to the stage and occupies no space beyond the screen frame it embodies. The curtains are accommodated at either side on rollers and brailled at the top, making the unit unusually compact.

Vallen automatic screen modifiers have been installed in many theatres throughout the country. Complete description of equipment and prices may be had from Vallen Electrical Co. Inc., Akron, Ohio.



UNDIRECTIONAL SPEAKERS

The loudspeaker herewith illustrated is manufactured by The Operadio Manufacturing Company, St. Charles, Ill. This is an electrodynamic air column speaker, furnished both in outdoor and indoor types for all public address purposes.

▲

375 WATT-75 VOLT 16 MM. PROJECTION LAMP

The Victor Animatograph Corporation, Davenport, Iowa, announces that the new 375 watt-75 volt lamp can be used in any Model 3 Victor cine'-projector that is equipped with the No. 10 Victor lamp rheostat, by having a slight change made in the rheostat resistance.

It is only necessary to return the rheostat to the factory as no change is required in the projector. A charge of $5 is made for changing the resistance in the rheostat.

After the revision is made, the rheostat can be operated with 250 watt-50 volt, 165 watt-30 volt and 375 watt-75 volt lamps. Also, the rheostat can be disconnected to permit the use of 200 watt-100 to 120 volt lamps in the same projector. Victor thus offers the widest range of lamp interchangeability of any manufacturer in the field.

▲

PHOTOCELLS

The G-M Laboratories, Inc., announce three new sizes of Visitron type "A" photoelectric cells. These additions bring the number of sizes and shapes of standard Visitron type "A" cells to a total of seven, which constitutes the most complete line of photoelectric cells manufactured in the United States.

There is a G-M Visitron suitable for use in every type of sound equipment manufactured in America. Their high sensitivity, low operating voltage, stability, and long life make Visitrons a valuable component of all sound systems and industrial appliances of every kind in which light sensitive cells are used.

▲

THE CUE-METER

A versatile and indispensible accessory of properly equipped projection rooms is the cue-meter manufactured by the Theatre Engineering Service Company, 1442 Beachwood Drive, Hollywood, Cal. This device indicates the correct time to start the motor and make changeover, and gives cue indications of all other operating essentials.

▲

A GOOD AMPLIFIER

The Model RV amplifier of the General Amplifier Co., 27 Commercial Ave., Cambridge, Mass., is a two stage a-c. operated voltage amplifier employing one –27 tube and two –45 tubes connected in push-pull. Due to the fact that it employs –45 tubes in the output, it may be used as an output stage where the power output requirements are of a low value, delivering in this respect approximately 4 watts of energy.

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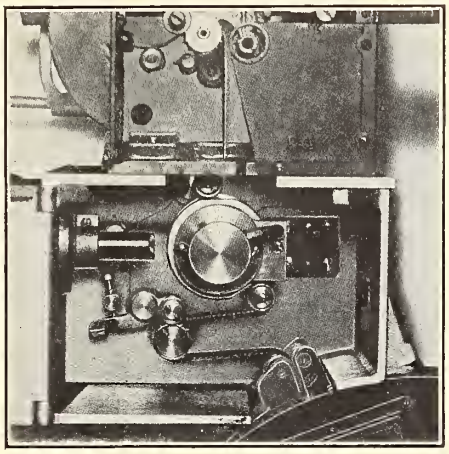

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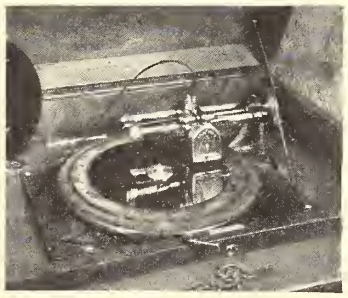

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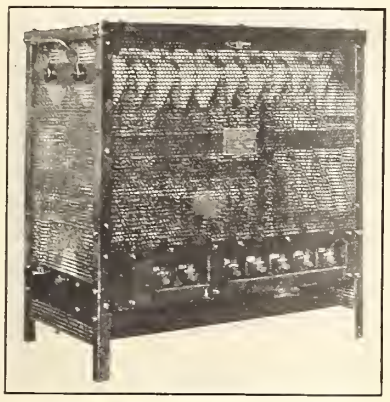

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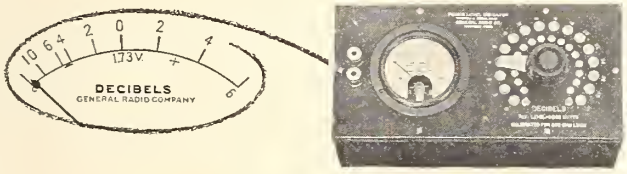

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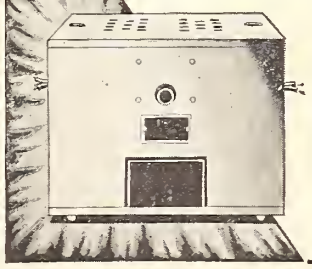

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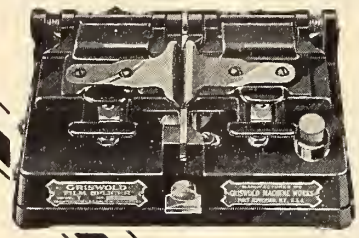

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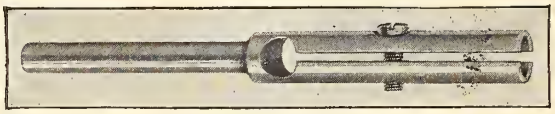

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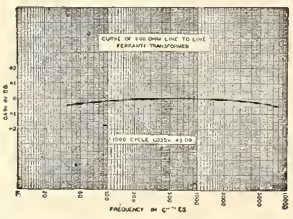

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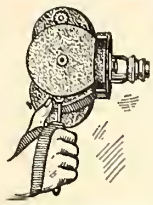

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Published monthly at Albany, N. Y., for April 1, 1931.

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Before me, a Notary Public in and for the State and county aforesaid, personally appeared B. S. Davis, who, having been duly sworn according to law, deposes and says that he is the Business Manager of PROJECTION ENGINEERING, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24th, 1912, embodied in section 411, Postal Laws and Regulations, to wit: 1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Bryan Davis Publishing Co., Inc., 52 Vanderbilt Avenue, New York; Editor, Donald McNicol, Roselle Park, N. J.; Managing Editor, F. Walen, Union City, N. J.; Business Manager, B. S. Davis, Scarsdale, N. Y. 2 That the owners are: Bryan Davis Public Co., Inc.; B. S. Davis, Scarsdale, N. Y.; Roy T. Atwood, Albany, N. Y.; G. R. Bacon, Douglaston, N. Y.; J. C. Munn, Union City, Pa.; J. A. Walker, Richmond Hill, N. Y.; A. B. Goodenough, New Rochelle, N. Y. 3. That the known bondholders, mortgagees, and other security holders owning or holding 1% or more of the total amount of bonds, mortgages, or other securities are: None. 4. That the two paragraphs next above giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where a stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustees is acting, is given; also, that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

(Signed) B. S. DAVIS, Business Manager.

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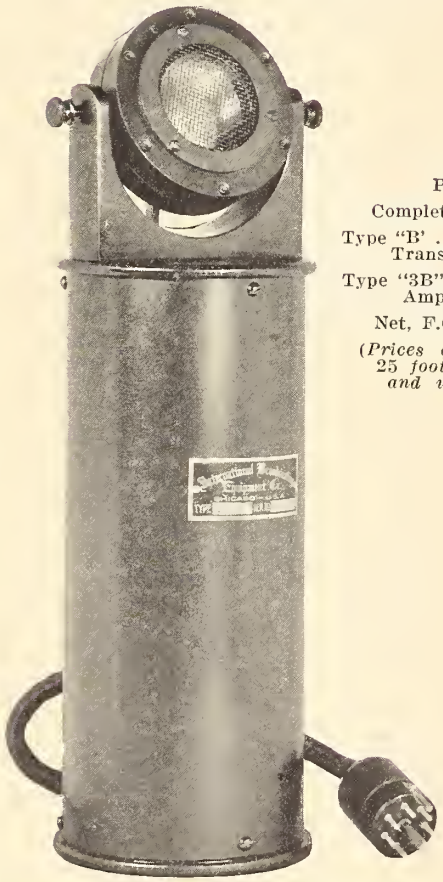

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MAY, 1931

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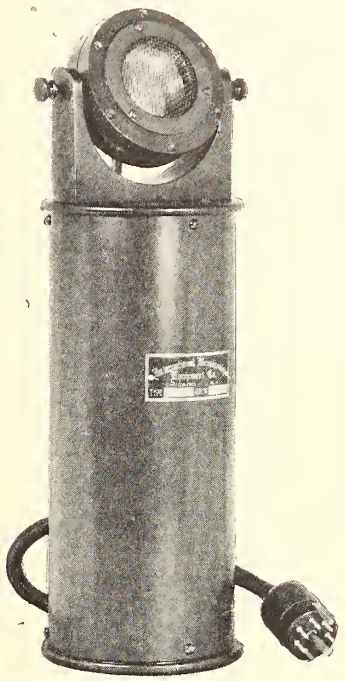

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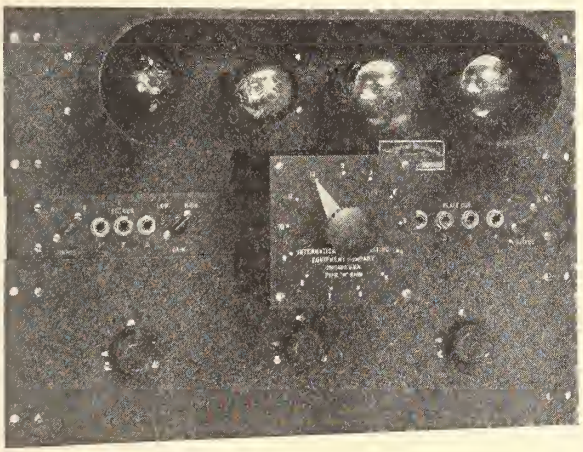

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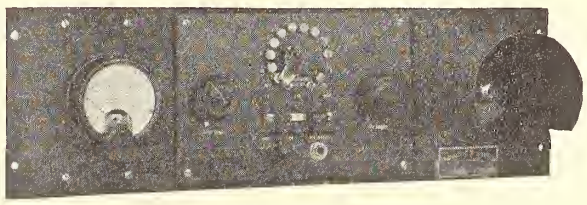

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Editorial

MAY, 1931

SUBJECTS FOR HOME MOVIES

ONE of the largest dealers in New York, retailing home movie-talkers, tells us that considering the times the demand for these instruments has during the past year been healthy. At present, with a slightly improved buying power the demand has sloped off noticeably. The reason advanced is that there is a paucity of new subjects.

In this situation there is opportunity. With a considerable number of the machines in homes throughout the country it would seem that manufacturers would sense the demand and take steps to meet it. If the rental and sales prices heretofore charged for films and discs, or duo-films, have not been high enough to make manufacture profitable perhaps the products, if of improved grade, would stand an increase in list.

▲

THE THIRST FOR KNOWLEDGE

IN the February, 1931 issue of PROJECTION ENGINEERING we published some of the questions included in An Examination for Projectionists. The response to this presentation was wide and enthusiastic. Scores of projectionists have written us to publish the complete list of examination questions. This we decided to do—one-half of the list appearing in this issue of PROJECTION ENGINEERING, the remainder to be presented in the June issue.

This demonstration of interest is an encouraging sign. It is a sure indication of a widespread desire on the part of the men in the projection rooms throughout the country for knowledge of direct use in the daily operations.

A list of technical questions propounded by those in authority does not in itself contain information, but it is of the utmost value in outlining and identifying the particular items of knowledge of importance to the men engaged in the business.

When a student (and we are all students) has before him a schedule of the things he should know he has in hand the first requisite of useful education. Forthwith his studies may become orderly, organized and purposeful. Sources of information are numerous—books, technical periodicals, and one's own daily experiences are available to all who desire to learn and progress.

SOUND SERVICING

THE inevitable has happened. The growth of sound installations during the past year has been so extensive that already a serious situation has developed in regard to servicing.

The two major companies which have sold or leased sound equipment to some six thousand theatres in the United States have well planned maintenance and servicing organizations. The sound installations put in by these two companies will be properly serviced.

However, there are about six thousand sound installations of various makes and brands which have been put in by the smaller, independent manufacturers. Also, in addition to the sound installations in theatres there are probably thousands of other places where sound or public-address systems have been put in.

It is in the case of these numerous miscellaneous sound installations that the need has grown for expert servicing. In time there may be opportunity for a large national servicing organization, but in the meantime there is an immediate opportunty for state and county units.

The growing correspondence carried on by PROJECTION ENGINEERING with users of sound systems indicates that many additional sound installations are contemplated for the coming year. Also, owners of systems now in service appear to be experiencing difficulty in procuring dependable replacements of parts. The situation throughout the country is such that engineers and servicemen competent to repair and maintain sound and public-address installations should soon sense the increasing opportunities for employment. Essentials for success are: knowledge of the equipment, industrious activity, and trustworthiness.

Donald McNicol

Editor.

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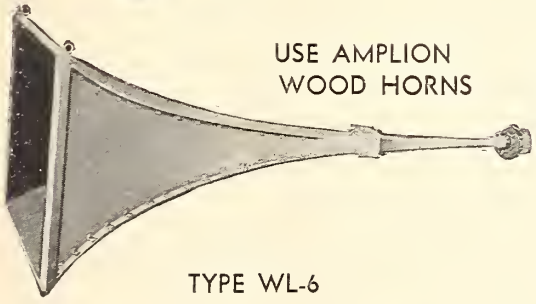

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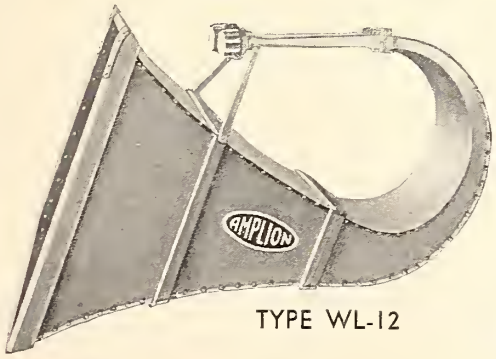

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Projection Engineering

MAY, 1931

Public address and sound engineering problems

By Ralph P. Glover

The Knowledge of Line Impedance Characteristics Established by Telephone Engineers May to Advantage Be Applied by Sound Engineers

AUDIO-FREQUENCY transmission lines, so long utilized and exhaustively studied by the telephone industry, are now important tools of the public-address and sound picture engineers. In permanent sound installations which have been carefully designed and constructed, we find many outstanding examples of adequate coverage combined with a minimum capital investment. In less carefully engineered installations, inattention to important details and fundamental principles almost invariably results in enormously reduced efficiency and a corresponding increase in the cost and extent of the required apparatus. The transmission line, whether long or short, is often the weak link in the chain. Some knowledge of its properties and characteristics, in several instances known to the writer, would have saved the difference between fifty-watt tubes and "a pair of two-fifties," with their respective associated apparatus.

Transmission lines, whether they be open wire, cable or merely twisted pair, have uniformly distributed constants of inductance, resistance, capacitance and leakance. The magnitude and proportion of these constants establish a definite set of transmission characteristics for each particular line. They affect the characteristic impedance of the line, the amount of attenuation and phase-shift of the signal attributable to the line itself, and govern the manner in which these effects vary with frequency. The distributed constants referred to depend mainly on the proximity and configuration of the conductors and upon the dielectric constant, insulation resistance and apportionment of the line insulation.

Fortunately, it is neither necessary nor desirable to consider any of the properties of transmission lines other than characteristic impedance, and to a lesser extent, attenuation, in this article. The technically-minded reader can draw on the excellent standard works on transmission theory should he desire to pursue the matter further[1].

When a generator is required to deliver power to a load, it is commonly appreciated that the maximum power will be transferred when the load impedance is the same as the internal output impedance of the generator. Likewise, when intervening apparatus exists between the generator and the ultimate load, this same equivalence of impedance must prevail at the junction points if each unit is to transmit the optimum amount of power. If the output and input impedances between particular units are not inherently identical, equivalence is obtained through the use of the proper impedance-matching transformer.

Value of Line Impedance

The transmission line is no exception to the impedance-matching principle. However, unless previous experience is available, the value of the line impedance is all too seldom known. In any event, the fact that the impedance of both line and terminal apparatus may vary considerably with frequency, calls for careful consideration. Especially under these conditions, does the efficiency of the system depend on enlightened technical judgment.

For an ideal transmission line; that is, one having zero conductor resistance and leakage conductance, the characteristic impedance (the value of impedance to be considered from the matching standpoint) is

$$Z_o = \sqrt{\frac{L}{C}} \qquad (1)$$

where L and C are the inductance and capacitance per unit length. It should be noted that the relation is entirely independent of the length of line and the frequency of transmission. For the more general case of a practical line, the expression becomes

$$Z_o = \sqrt{\frac{R + j\omega L}{G + j\omega C}} \qquad (2)$$

where R and G are the conductor resistance and leakage conductance per unit

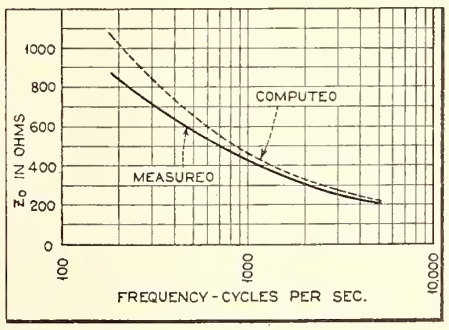

Fig. 1. Characteristic impedance of No. 19 rubber covered twisted pair. C=0.00129 m.f. per 100 feet loop. R=1.73 ohms per 100 feet loop.

[1] *For instance, K. S. Johnson, "Transmission Circuits for Telephonic Transmission," Van Nostrand.*

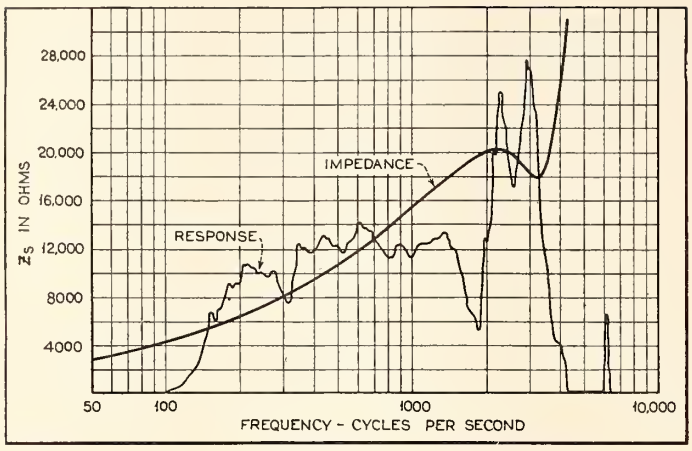

Fig. 2. R103 magnetic speaker impedance and response.

length, respectively, and $\omega = 2\pi f$. As before, the impedance is independent of the length but, except in special cases, will be a function of frequency.

When dealing with cables and twisted pair, (lamp cord, for instance) the most common transmission lines found in sound work of all sorts, a simplified expression for the characteristic impedance may be used due to the fact that the inductance and leakage conductance are generally negligible. The result is

$$Z_o = \sqrt{\frac{R}{j\,\omega\,C}} = \sqrt{\left(\frac{1}{j\,\omega\,C}\right)(R)} \qquad (3)$$

The expression is given in the second form because it demonstrates that the characteristic impedance of a uniform line is also the square root of the product of open-circuit and short-circuit impedances (in other words, the geometric mean of the open-circuit and short-circuit impedances). When the line is open at the far end, the impedance which obtains is the capacity reactance of the conductors at the frequency of measurement. When short-circuited, the impedance will be entirely the resistance of the "go and return" conductors. Indeed, this serves to describe the usual method of measuring characteristic impedance.

An Equivalent Method

An equivalent method consists of measuring the capacity of the open line with, for instance, a portable buzzer capacity bridge and then measuring the resistance with the far ends short-circuited by means of a low-reading ohmmeter or Wheatstone bridge. The impedance at any frequency can then be calculated from expression (3). Fig. 1 was obtained from such measurements on a length of No. 19 B&S gauge, rubber-insulated twisted pair. The computed curve was calculated from resistance and capacitance data while the other curve was the result of actual impedance measurements. The values of impedance are typical of those found in practice for this kind of line and vary from about 950 ohms at 200 c.p.s. to 250 ohms at 3,000 c.p.s.

The technician is now face to face with the problem of selecting the proper value of impedance from his determined data so that an impedance match can be made. Impedances are frequently matched at the conventional frequency of 1,000 cycles and although this choice is infinitely better than sheer guesswork, it is doubtful that this method can be used with universal success. Certainly in many cases better results are secured by the choice of other values of impedance for matching.

As has been pointed out, matching to the source or load can probably be obtained at but one frequency and at all other frequencies there will be a loss of power due to mismatching. This mismatching loss, occurring at the generator and load junctions of the transmission line, is by far the most serious loss encountered in this sort of transmission and has a marked effect on both the quality and power output of the system. The actual attenuation for the twisted pair of Fig. 1 is only about one-half decibel per thousand loop feet at 5,000 c.p.s. over the line itself and is entirely negligible.

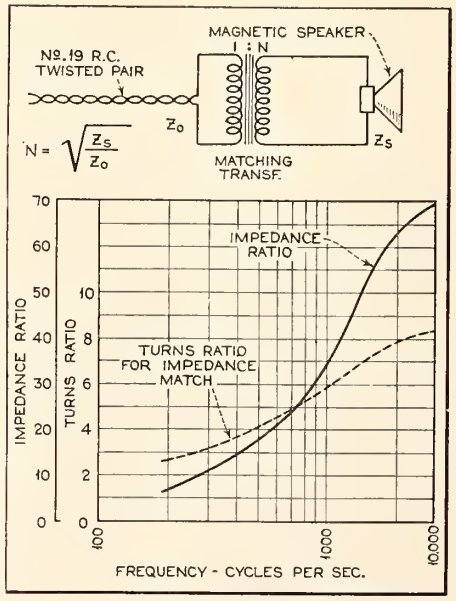

Fig. 3. Ratio of speaker impedance to line impedance.

A Specific Problem

A practical method of solving such problems is best indicated by the discussion of a specific case. Other cases involving loads of different character may be handled in an analogous manner. Fig. 2 shows impedance and response curves for a high-impedance magnetic speaker which it is desired to feed from the transmission line of Fig. 1. A step-up transformer will of course be necessary between the low-impedance line and the speaker and our problem thus includes the selection of the proper turn ratio for this transformer.

In Fig. 3, the ratio of speaker impedance to line impedance has been plotted for the important frequencies within the range of reproduction of the speaker. The turns ratio required for matching at any frequency is also given, calculated from the impedance ratio as indicated.

The rising response tendency (the ordinates are proportional to decibels) toward the high frequencies in Fig. 2 leads to the conclusion that some sacrifice of power in this range would not be objectionable and might even be desirable. Remembering that the greater part of the power of the human voice lies in the frequencies below 1,000 cycles per second, we might well decide to match in the region between 200 and 1,000 c.p.s. A turns ratio of 1 to 4, step-up, for the transformer would be convenient and would match impedances at 500 cycles.

In case the loudspeaker impedance and response data are not available, the manufacturers will undoubtedly be glad to supply information or suggest the proper transformer ratio. Where the loudspeaker impedance is known, it is advisable to make a preliminary trial using a variable ratio impedance-matching transformer, starting the test with the ratio indicated by the impedance relationships at about 1,000 cycles. The ratio can then be varied either way until the most satisfactory compromise between volume and quality is secured. A fixed ratio transformer of the indicated value may then be substituted if desired.

The considerations are somewhat different at the junction point between the line and the power amplifier. Here it is necessary to remember that the amplifier should be terminated by approximately twice its plate impedance for maximum *undistorted* power output. We are faced with a compromise, since we have large variations in load impedance to contend with again. A good solution, however, would consist of a step-down transformer between the tube and line which would reflect

(Concluded on page 22)

The unsound sound business

By Henry L. Williams

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The Imminent Large Magnitude of the Sound Amplification Business Calls for Organized Merchandising

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"CONFUSION worse confounded" is the dire fate in store for the Sound business during 1931 unless a halt is called to the haphazard merchandising methods indulged in by ninetey per cent of the manufacturers.

With the decline of the parts business, more and more of these manufacturers have turned their attention to public-address equipment. With many of them such products are still a sideline, which makes matters even worse. Practically all of them, whether specialists or not, appear to be satisfied with the manufacturing, and leave the distribution and merchandising to luck and ill-chosen representatives. This year finds a rapidly expanding market for sound equipment; month by month the sound business grows more and more attractive, and *now* is the time for manufacturers to bring their scheme of distribution into line with the actual marketing conditions, and to look ahead a little and see where their present policies are leading them.

At the present time there are about a dozen sound equipment manufacturers actively engaged. A couple of them operate under license, the others claim there is no "patent situation," a matter that has never been definitely decided and operates to the disadvantage of the humble salesman. Apparently this state of affairs will continue for some time to come, as the alleged patent holders evidently prefer to postpone the issue and content themselves with holding a real or imaginary big stick over the heads of the sellers and buyers of unlicensed equipment, to the detriment of both.

Who Sells Sound Equipment?

One of the really big and fundamental problems facing the manufacturers concerns who shall sell sound equipment and who shall not. As already pointed out, a very haphazard condition exists in this respect, seriously retarding the growth of the industry and clogging the progress of education among the potential users of sound equipment. Practically all the factories have their local representatives, who, for the most part, are distinctly not sound engineers. These men sell to radio jobbers on occasion and more often to radio dealers; to amateur sound engineers; direct to theatres and schools; to broadcasting stations; to municipal authorities; to anyone who has the cash to buy. Discounts for the most part are decided by these representatives on the spur of the moment. Protection for the legitimate sound concern is usually a thing unknown.

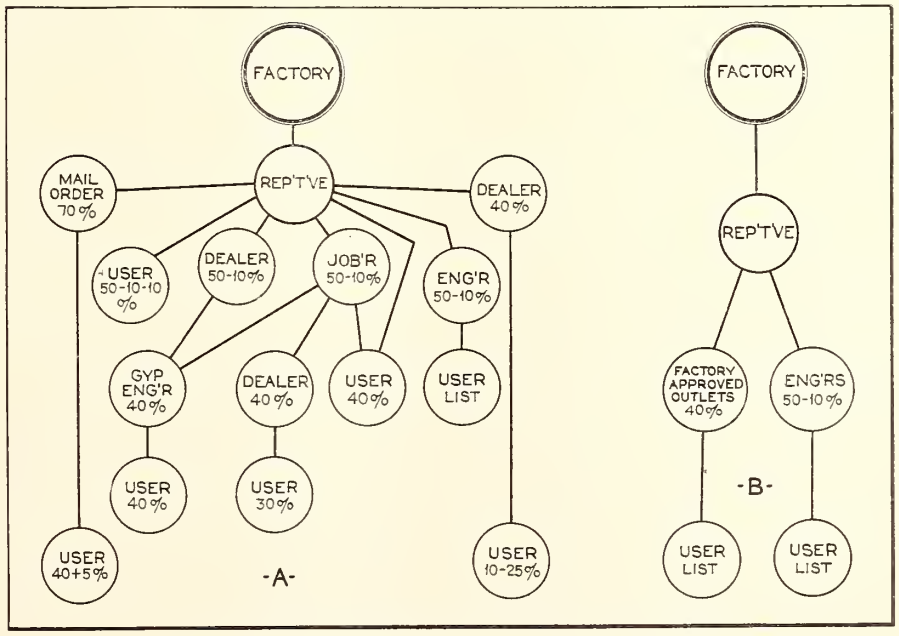
An immediate result of this merchandising chaos is that the sound installation people are often in direct competition with the people who should be their customers, and another is that installations are made by people who have no idea of what good sound is or how to procure it. This is one of the reasons why the market for sound equipment has been almost killed in many localities, for the results produced have been so atrocious that other prospects have grown to think that nothing better need be expected, or is available.

The first thing to be done therefore is to clean shop by establishing definite discounts to specified customers. The only true customers of sound equipment manufacturers should be sound installation concerns, and then only those of them who conform to certain standards. What those standards should be is very easily determined by the factory, and when such outlets are not available it might well be worth the while considering the establishment of installation units either by direct financing or through the local representative's organization.

In any event, it is of paramount importance that the factory control, to a large degree, the use of the products they make. In the sound business as in few others, the operation of the equipment after installation is of direct importance to the factory, and it is well worth the factory's time to see that it is at least given a chance to operate as it should. More sales have been lost through careless or ignorant installation than through any other one cause.

Sound Engineers

In seeking desirable outlets, the factories and their representatives should realize that a radio engineer is not necessarily a sound engineer, and that sound equipment installation is a highly technical business in itself. The work that the sound engineers do is of value because technical knowledge is a vital necessity, and there is far more to a good sound installation than a collec-



Which system of merchandising sound will be followed?

tion of sundry apparatus. That is one reason why sound equipment should not be sold to radio dealers or jobbers for resale to pseudo-installation men who work on a cost-plus basis, charging only for the time involved.

It cannot be emphasized too often that the salvation of the sound industry is in the hands of the sound engineers, and the wisest course they can pursue is to bend every effort to see that only approved sound engineers have the opportunity of handling their equipment. Inasmuch as the prosperity of the sound industry depends directly upon the prosperity of sound engineers, it would be good policy to give them every financial advantage and minimize internal competition through proper grading of discounts and protection of territory. There is sufficient competition abroad without introducing internecine warfare in the form of rivalry between concerns merchandising the same factory's equipment.

As things are, it often happens that anyone at all can buy from factory representatives at forty off, the same discount that is offered to radio dealers. Radio jobbers, who are so often also retailers can generally command fifty and ten, which is the maximum for sound engineering concerns. Public institutions, such as municipal departments, hospitals, etc., can sometimes demand another ten per cent over what the sound engineers get. To all intents and purposes therefore, the actual retail price is forty off list, and the extra ten and ten is far too little to keep the sound men in business. Courtesy discounts of all kinds add to the already unhealthy state described, and only drastic action will put the industry on a really stable basis.

The logical course seems to be to appoint only approved engineers, give them the maximum discounts, and through the local representatives, keep a close tab on the work they do. All other equipment should be sold through the representative only to customers who are not likely to injure the reputation of the merchandise by public demonstration of inferior quality due to faulty assembly or hookup.

Only by the assumption of such a definite policy will the sound industry build a firm foundation for prosperity in the days to come.

Loudspeakers Added to Existing Public-Address or Radio Installations

By D. B. Looney*

ONE of the more common problems in connection with public-address and centralized radio is that of installing additional loudspeakers. In what follows some ideas on this subject will be presented.

Men who have had radio servicing experience, as well as theatre projectionists, now have enlarged opportunity for personal earnings as the field of sound amplification expands.

In the immediate future real business is in sight in installing additional loudspeakers at dance halls, bathing beaches, stores or in private homes. Many home owners would like an extra speaker on their porch, in the garden or kitchen. This last appeals strongly to the busy housewife and is a good selling point.

Fig. 1 shows how we may connect as many as thirty magnetic speakers to a single broadcast receiver (or phonograph amplifier). Connections for an additional dynamic speaker are also shown.

The two 2 mfd. blocking condensers are to prevent the direct plate current from flowing through the speakers while at the same time allowing the alternating component of the plate current to flow through the magnetic speaker windings. As these speakers are connected in parallel, the maximum volume from each will be the same. The individual volume is controlled by the 100,000 ohm resistors. Don't run the common lead from the output of the receiver in metal covered wire as the capacity effect would decrease the volume. Good rubber covered wire will suffice. There is no fire hazard if the 2 mfd. condensers are built to withstand a potential of 400 volts when using 245 tubes and 600 volts with 250 tubes. However, the leads should be well separated.

N.R.I. Technical Staff.

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An everyday problem answered in an understandable manner.

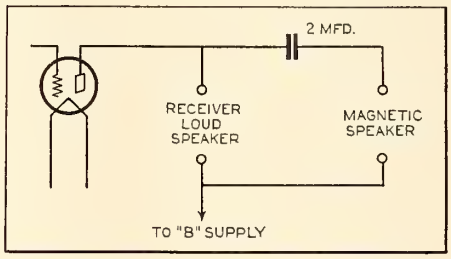


Fig. 2. Adding speaker where no push-pull amplification.

When using extra dynamic speakers, connections may be made directly across the output of the receiver as shown, although if the dynamic speaker input impedance is like that of a magnetic speaker, it may be connected with the latter. We must, however, use a separate field excitation for the additional speaker. Most dynamic speakers have incorporated in them either a dry metallic rectifier or a vacuum tube rectifier. Suitable speakers can be secured from dealers.

When you wish to add additional speakers to a receiver which does not use a push-pull output, follow the hookup shown in Fig. 2.

Many manufacturers of broadcast receivers have plans and parts already assembled for adding additional speakers to their sets. On a big job it would be a good idea to write to the receiver manufacturer stating all the facts of the case—the type of receiver—the number and type of speakers to be added and any constructional details which have to be surmounted. Manufacturers are always glad to cooperate on matters of this sort and by writing to them mistakes may be avoided and much time saved.

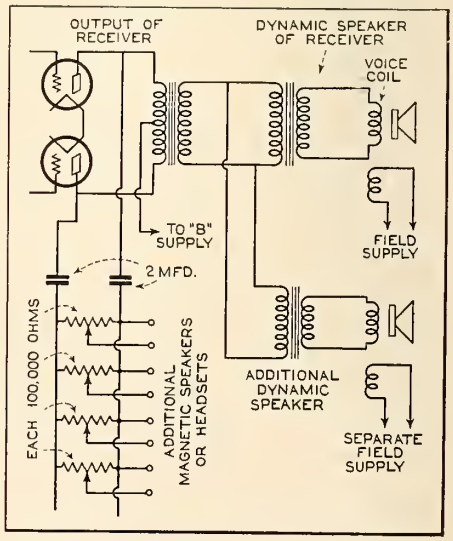


Fig. 1. Adding speakers with push-pull.

Film recording in sound motion pictures

Part I

By Charles Felstead*

Detailed description of procedure in making sound records on film, including Fox Movietone and Western Electric

WITH the great advances that were made in the development of the microphone and of audio amplification, the engineers who were working on the problem of finding a method of recording sound to accompany the motion picture, were faced only by the difficulty of creating a device that would transform the electrical copy of the sound waves into some other form of energy that could be easily recorded on a suitable sensitive medium. The amount of audio amplification that they had available assured the engineers that the electric current would be of sufficient magnitude to operate the device after it had been perfected, and they knew that the fidelity of the amplification was great enough to produce an electric current having practically the same wave forms and proportionate amplitudes as the sound-pressure waves that they wished to record. The development work progressed along several lines, as is demonstrated by the fact that there are a number of distinctly different sound recording systems in use in motion picture work at the present time. In some of them, the electrical energy is caused to operate a device that modulates a beam of light, either at the source or after the light has been generated; and in another recording system, the electrical energy is transformed directly into suitable mechanical energy. In the first case, the modulated beam of light is permitted to fall on a moving strip of unexposed motion picture film, thereby creating a photographic image of itself as a narrow *sound track* near one edge of the film, and in the other recording system the mechanical energy records itself as a varying trace on a soft wax record. These are rather roundabout methods of recording sound, but they are the best that is now available. It is probable that eventually the speech current, as this changing electric current that represents the sound waves is called, will be recorded directly on some medium without recourse to the expedient of first changing it into some other form of energy that is more easily recorded; but that development will not come about until some method of so recording electrical energy has been devised.

Two Types of Sound Film

The two general methods of recording sound on film are known as the variable area-fixed density and the variable density-fixed area methods. Since we have not the space to enter into a detailed discussion of these two types and systems of film recording, we will take up only the variable density-fixed area method in the present paper. There are two recording systems that employ this method of recording sound on film. In the Fox Movietone, this type of sound track is produced by the flickering light from a lamp that is connected directly to the output of the recording amplifiers, while in the Western Electric system of recording, the modulation of the light beam is accomplished by a device called a "light valve" which is interposed between a light source of constant intensity and the moving film. In order not to make it necessary to review the complicated electrical equipment that is connected between the microphones on the sound stage and the recording machine in which the film is exposed to the modulated light beam, we will assume that we have a speech current at the recording machine that is of the proper amplitude and that is a faithful copy of the sound waves which we wish to record. In addition to this speech circuit, we must take for granted that there are the necessary battery and power circuits also entering the recording room.

The machine in which the film is exposed to this varying light beam is known as the *film recording machine* and is comparable to the motion picture camera in which other film is exposed to the light reflected from a scene that is to be photographed. Both the film recording machine in the recording room and the motion picture camera on the sound stage are driven by special "interlocked" motors that start and stop at exactly the same time and run at precisely the same speed. The speed of these motors is regulated so that they never vary by more than one-tenth of one per cent from a fixed speed of exactly 1200 r.p.m. when they are running. The use of interlocked motors makes it possible to place start marks on the film in both the camera and recording machine, and then to print the two pieces of film together after they have been exposed, with the assurance that they will match perfectly. Because the two start marks were made at identical places on the pieces of film in both machines and the machines were run at precisely the same speed, the picture and sound track on the two pieces of film will coincide exactly. Another similarity in the camera and recording machine is in the light-tight construction of the

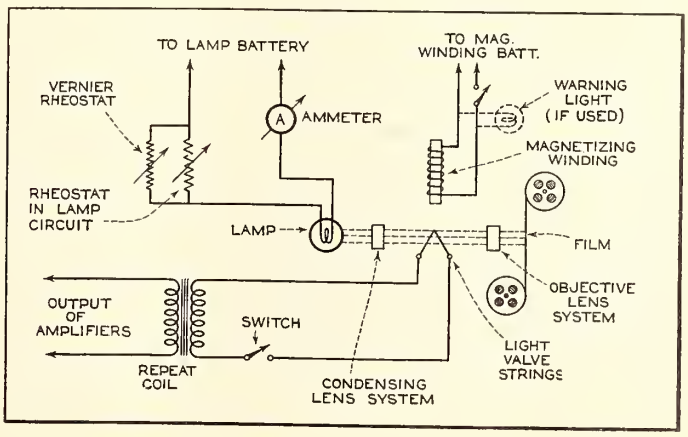
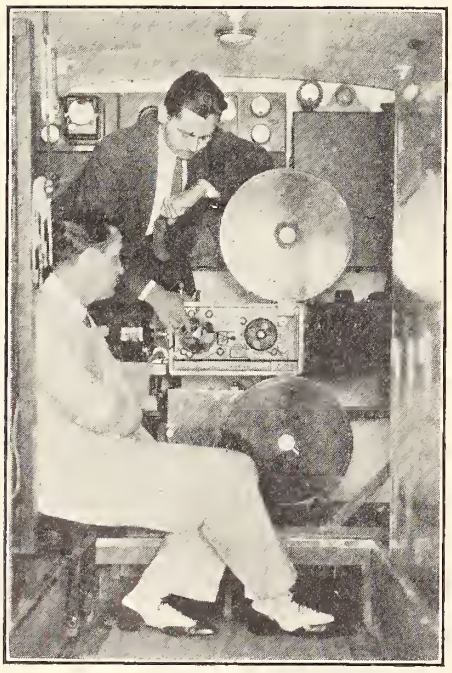


Fig. 1. Schematic diagram of battery circuits.

*Sound Engineer, Universal Pictures Corp.

box in which the film is exposed to light shining through a lens system in one end. However, the two machines differ in that the film moves uniformly and continuously past the lens system in the recording machine, whereas in the camera the film is drawn down intermittently a frame at a time past the lens. The same type of film magazine is employed now generally on both machines, and they are both equipped with footage counters that indicate the number of feet of film run through the machine.

The mechanical construction of a film recording machine is evident from the accompanying photograph. The rectangular metal box is the chamber in which the film is exposed, and the two drum-shaped containers are the magazines in which the film is held before and after exposure. The film travels down from the loaded magazine through the recording machine and on into the other magazine. On the end of the exposure chamber opposite the driving motor is the lens system and the light valve assembly. Farther out on this same end of the machine is the lamp house in which the lamp that furnishes the light of constant intensity is located. The footage indicators are the two knob and pointer arrangements on the front of the exposure chamber. The whole recording machine and motor assembly is built on a special concrete foundation. Just beneath the center of the machine is suspended a square metal box carrying the photoelectric cell amplifier, the function of which was discussed in a preceding article. The large panel on the wall back of each recording machine is the control board on which are mounted the battery and speech circuit controls and meters and the other equipment that is associated with the recording machine. There are usually two film recording machines attached to each recording channel. The film magazines are removable to permit loading and unloading the film, and the door on the front of the exposure chamber is easily opened to allow the threading of the machine and the punching of the film for the start mark. The film magazine from which the film is taken is known as the feed magazine and the other one is termed the take-up magazine.



Courtesy Hal Roach Studios

Loaded film recording machine.

It is necessary that the angular velocity with which the film is carried past the lens system that focuses the image of the light valve onto the film be as uniform as it is physically possible to make it. In the photograph showing a loaded film recording machine, it will be observed that there are two large wheels around which the film is carried inside of the exposure chamber. These wheels are known as the sprockets. It is while passing over the left-hand sprocket, which engages just twenty of the sprocket holes in the edge of the film, that the film is exposed by the light passing through the light valve. These sprockets are both driven by the motor shaft through a worm and worm-wheel, but whereas the right-hand sprocket is driven directly by the shaft of the worm-wheel, the left-hand sprocket is driven through a special mechanical filter. This mechanical filter is a form of heavy flywheel that is connected directly to the sprocket shaft and through a filter arrangement of springs to the shaft carrying the worm-wheel drive.

Mechanical Filter

The purpose of this mechanical filter is to iron out any variations that may occur in the speed of the driving motor and to compensate for any imperfections in the driving gears. The heavy flywheel built directly on the motor shaft likewise helps to steady the speed of the motor. All of this mechanical filtering has for its object the elimination of flutter in the sound track, which is produced by any intermittent variations in the angular velocity of the film as it is carried past the point of exposure. The speed at which the film is pulled through the recording machine is precisely ninety feet a minute, corresponding to a driving motor speed of 1200 r.p.m., and in the ideal recording machine, the film would pass the exposing light beam at this speed with absolute uniformity and steadiness in rate of travel. The uniform rotation of the left-hand sprocket wheel is not affected by variations in the rotation of the right-hand, or feed, sprocket, due to the two loops of film by which the sprockets are connected, because any variations in the rotation of the feed sprocket from normal will be absorbed by these two film loops and have no effect on the angular velocity of the left-hand sprocket. This right-hand feed sprocket draws the film out of one magazine and feeds it down to the other take-up magazine. If a steady sine wave representing any audio frequency, such as 1000 cycles per second, is recorded and there is any flutter present in the recording machine, the recorded sound when it is projected will vary up and down in tone. The same thing happens to any sound that is recorded in a machine in which there is flutter present, but it is more noticeable with a steady tone because of the pureness of the note.

The Assembly

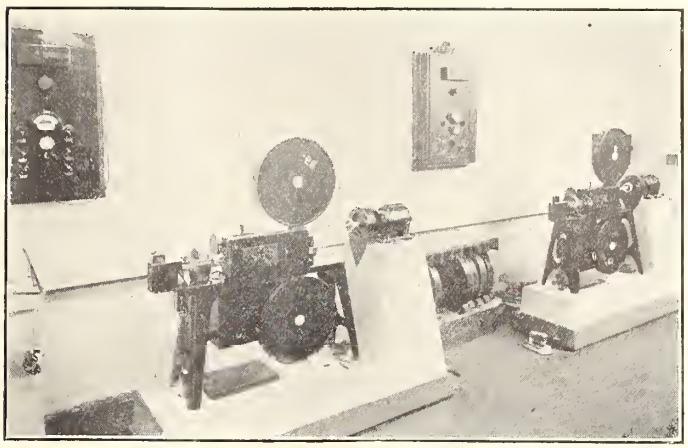
Directly ahead of the lens system attached to the front end of the exposure chamber, and through which the modulated light shines on the film and exposes it, is the magnetizing winding and the light valve assembly. Still farther out on this end of the recording machine is the metal lamp house in which the lamp that provides the light for exposing the film is located. Between the lamp and the light valve is a condensing lens system that serves to concentrate the light from the lamp onto the opening in the frame of the light valve. The mounting of the lamp is adjustable so that it can be moved around to the position that permits the condensing lens to focus the light most sharply on the hole in the light valve frame. This is one of the adjustments that must be made every morning by the men who operate the film recording machines. An eighteen-ampere projection lamp with a heavy flat ribbon filament less than an inch long is used. It is lighted from a twelve-volt lamp battery through an adjustable rheostat. The lamp and light valve are so arranged that the plane of the ribbon filament of the lamp is focused on the plane of the ribbons in the light valve. The metal housing that may be seen over this lamp is for the purpose of shielding the recording operator's eyes from the very bright light of the lamp. Since the speed with which the film moves past the lens system in the recording machine is constant and unalterable, the degree of exposure of the sound track is regulated by varying the intensity of the light from this lamp. In order that a sound track of the correct average density will be obtained, it is necessary that just the right amount of current be supplied to the lamp. There is a vernier rheostat on the main rheostat that controls this lamp, and the two of them, with the ammeter that indicates the amount of current drawn by the lamp, are mounted on the large control panel on the wall. The arrangement of the battery circuits

is shown schematically in Fig. 1. The proper lamp current for each lamp is given the recording men and it is their duty to maintain the current at exactly that value at all times during the making of sound *takes*.

Modulating Device

The assembly of electromagnet and light valve that constitutes the light beam modulating device is mounted between the lamp house and the objective lens system on the exposure chamber. The field winding of the electromagnet, which is sometimes known as the magnetizing winding, is a large multi-layer coil of wire wound around the center leg of an E-shaped core, with the open part of the E facing the lamp house. The end of this center leg of the core, which is shorter than the other two legs of the core, is wedge-shaped, with the long way of the wedge on the same plane as the plane of the light valve ribbons. There is an opening in the face of this wedge that is eight mils wide by 256 mils long, and this opening is part of a slot that tapers toward the back of the E to form an opening 204 mils wide by 256 mils long facing the objective lens system in the end of the exposure chamber. After the elctromagnet assembly has been lined up at the factory to exactly the right position, it is fastened securely in place and the screw heads covered with sealing wax. This is to prevent any shifting in the alignment of the slot through which the light shines. There is no control in the magnetizing winding circuit other than the key switch mounted on the panel on the wall. The winding operates directly from a twelve-volt battery without any series resistance. Failure on the part of the recording operator to turn on the magnetizing winding will result in sound not being recorded on the film, so it is well to have a signal light in this circuit to serve as an indicator when the key switch is turned to the on position.

Sound film recording room, Universal Sound Laboratory.



Courtesy Universal Pictures Corpn.

CAMERA SILENCING

THE producers-Technicians Committee of the Academy of Motion Picture Arts and Sciences heard reports recently on camera silencing, the standard release print survey, cue sheets, film processing, supersensitive film, and other technical developments in the industry. M. C. Levee presided.

At the meeting it was reported that sixty first cameramen, representing all Hollywood studios, had replied to the questionnaire sent out in March by the camera silencing subcommittee. Ninety-one per cent of the replies advocate strong efforts toward the development of cameras which would not require blimps or covers of any sort. Fifty-two per cent of these replies urged such efforts in strong terms.

The weight of the blimps in use was condemned by 90 per cent of the replies; the bulk by 87 per cent. Fifty-five per cent said the blimps made focussing difficult and 73 per cent said they crowded the sets uncomfortably on close-ups. Practically every type of camera cover in use in Hollywood was criticized for one or more of these reasons.

At the meeting it was resolved to bring this situation to the attention of the camera manufacturers and inquire what efforts are being made toward the production of a silent camera. The Committee will offer to have studio experts confer with the manufacturers in an endeavor to advance such efforts.

The camera silencing subcommittee consists of Kenneth F. Morgan, Frederick M. Sammis, and Lester Cowan, manager Academy Technical Bureau.

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RICHARD W. COTTON

Herewith we present a likeness of Mr. Richard W. Cotton, Sales Manager of the Samson Electric Company, Canton, Mass. Mr. Cotton is well known throughout the sound field as the originator of the "PAM" sound amplifier, widely used throughout the world.

RICHARD W. COTTON

GOVERNMENT MAKES TALKIES

TWO government departments in Washington are now engaged in the production of sound motion pictures, RCA Photophone sound recording and reproducing units having been installed by the Signal Corps of the United States Army and the Department of Agriculture. The first subject made by the Signal Corps under the direction of Major C. W. Lewis, a well-assembled picture describing the latest developments in anti-aircraft artillery by the ordnance department, was presented for the first time at the opening of the new sound studio and projection room in the extension service building of the Department of Agriculture.

About seventy high officials and other executives of the Department of Agriculture attended the opening of the new studio when a special programme was presented under the direction of Raymond Evans, chief of the office of motion pictures of the department. Prior to the beginning of the programme, Clyde W. Warburton, director of extension service, gave a brief talk in which he told of the department's activities in connection with the distribution of silent motion pictures for the past several years and the plans now being made for similar distribution of sound pictures. The pictures produced by the Department of Agriculture are sent to schools, churches, granges and other organizations throughout the United States.

The high intensity arc in projection

By E. R. Geib*

This article contains directly useful information for projectionists on how to obtain the most brilliant light.

NOT so many years ago, a 50-ampere direct-current straight arc was considered a very powerful light source. By "straight arc" we have reference to the type in which both the positive and negative carbons were burned in a position shown in Fig. 1. The carbons were of the grade known as neutral cored, i. e., no special light producing materials were placed in the core. The light came entirely from the crater. The intrinsic brilliancy, i. e., the brightness of such an arc is 130 candle power per square millimeter.

Gradually, larger theatres were built and stronger light sources were required. The current was increased to

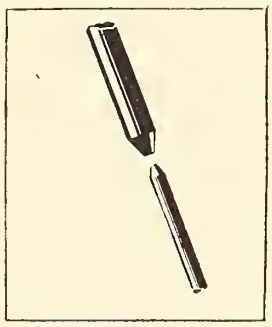


Fig. 1. D-C. straight arc.

75-100 and in some few cases to 125-140 amperes. It was not long before the light at even these amperages proved inadequate. This condition was met by the development of the high intensity projector arc. When first introduced it was operated at 75 amperes, but within a short time most high intensity arcs were operated at 100-125 amperes. It is this type of arc that we shall discuss in this article. The lamps used are of the Hall & Connolly (H. & C.) Ashcraft, and Brenkert types.

Sound film with its necessary semi-porous screens, color photography, wide pictures and larger theatres, now makes necessary the procurement of even more light than has been obtainable from the high intensity lamp operated at 125 amperes. In general there are three ways in which additional light can be obtained:

First: By the development of higher powered light sources. Super high intensity carbons have been produced

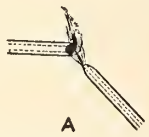


Fig. 2. High intensity arc.

which will operate at 250 amperes. The intrinsic brilliancy of these carbons is approximately 1200 candle power per square millimeter, which is even higher than the sun at zenith. These carbons are not yet available for the projection of motion pictures.

Second: More efficient high intensity projection lamps. The lamp manufacturers are now at work on this problem.

Third: The procurement of more light from present equipment and from present high intensity carbon trims. There is a way in which this can be done and many projectionists have already discovered the method. We shall attempt to describe it briefly in the hope that more projectionists may avail themselves of the maximum amount of light and steadiness available from the present 13.6 mm. H. I. projection carbons.

Let us first study the characteristics of high intensity arcs. With the straight arc, Fig. 1, the light came only from the crater. In the case of the high intensity arc, though, the light

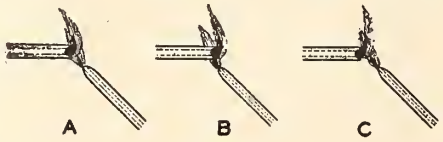


Fig. 3.

emanates from two distinct sources—the crater and the tail flame. (See Fig. 2.)

The light from the tail flame represents about 30 per cent of the total light emitted. However, this tail flame cannot be utilized for projection purposes because practically none of it can be focused and thus picked up by the optical system. We are interested, therefore, only in the crater light.

Position of Carbon

The candle power as well as the steadiness of operation is affected by the angle and relative position of the negative carbon with respect to the positive crater and by the voltage maintained across the arc. The angle is usually fixed by the lamp manufacturers. The position of the positive carbon, however, with respect to the negative can be changed by moving the positive backward or forward. The correct position is a matter of great importance as we shall see later. From Fig. 3-A it is observed that the positive carbon burns with a cup-shaped crater and that the negative arc stream tends to direct the mass of light produced by the positive carbon. By some, it is claimed that the light in this crater takes the form of a gas ball; others term it a mass of vapor. By whatever term you choose to call it, the object is to keep the hot gases confined in the cup-shaped crater. If the negative carbon is too close to the positive (Fig. 3-B) the negative flame appears to impinge on the hot gases in the positive crater with such force that they actually drive them out of the cup-shaped crater with a consequent loss of light and steadiness. In other words, the light actually spills out of the crater. If the negative is too far away from the positive (Fig. 3-C) then there is apparently not sufficient force to the negative flame to confine the gases in the positive crater and again there is a

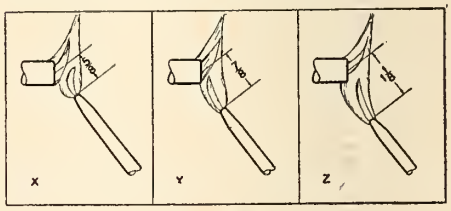


Fig. 4.

loss of light. From this, it will be seen that the proper arc length or voltage is very necessary if the best results are to be obtained.

The 13.6 mm. x 20 national high intensity projector carbons are designed for 110-125 ampere service and when operated in this current range, the arc voltage should be approximately 67-73 volts. The 16 mm. national high intensity projector carbons are designed for 140-150 ampere service and in this current range the best results are ob-

* National Carbon Co., Cleveland, Ohio.

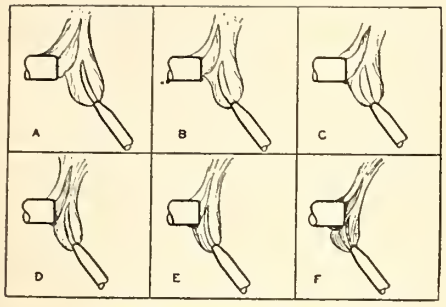


Fig. 5. 120-ampere arcs.

tained when the arc voltage is 73-83 volts. Although this article is on the subject of high amperage high intensity carbons, it might be stated in passing that a 9 mm. national H. I. reflecting arc projector carbon which is designed for 60-70 amperes, operates best at 48-55 volts across the arc. In general, if lower currents are used, the voltage should be correspondingly decreased. Conversely, if the current is increased the arc voltage should likewise be increased somewhat.

Arc Voltages

The question of arc voltages, however, is tied in very closely with the relative position of the positive and negative carbons and this relationship is probably more important than the arc voltage. In Fig. 4 we have graphic representations of three 70-volt arcs, but the arc lengths measured as shown in the figure vary from 1⅛ to ⅝ in. In X the negative flame does not touch the lower part of the positive carbon; in Y it just touches it and in Z it overlaps it considerably. These arcs give entirely different results in quantity and quality of crater light and the projectionist would only be confused by any voltage specifications without qualification as to the relative position of the positive and negative carbons. The latter relationship is probably more important than the arc voltage.

In Fig. 5 are shown graphic representations of the arcs obtained at 120 amperes (13.6 mm. x 20 national high intensity positives and ⅜ x 9 Orotip negative carbons were used) by moving the positive carbon successive steps of ⅛ inch along its axis. The arc voltage for this particular set varies from 86 in position A to 55 volts in position F. The negative flame in position A, it will be observed, is considerably ahead of the positive so that the positive flame actually rolls out of the bottom of the positive crater before the negative flame strikes it and diverts it upward. As the positive carbon is moved ahead this condition is altered, so that at D the edge of the negative flame just touches the lower edge of the positive carbon and practically the whole negative flame is sweeping across the crater opening as though compressing the positive flame. Finally, at F a good portion of the negative flame plays against the bottom of the positive carbon and again only a part sweeps across the positive crater. The values of relative light and arc voltage for these different arcs at 120 amperes are shown in Fig. 6. The maximum useful light is obtained at position D (as would be expected from the above description of the action of the negative flame against the positive crater opening). The light diminishes as the positive is moved in either direction from position D.

Stability

Unfortunately the position of maximum light is not the position of maximum steadiness. With the arc in position A, the direction of the positive flame from the crater is not stable, resulting in many large flickers in the crater or useful light. This condition is improved as the positive carbon is moved forward so that the large flickers decrease and are practically eliminated at positions C and D. In these positions small flickers of rather short duration are evident. The negative flame is either just hitting or just clearing the lower side of the positive carbon in these positions and tends to oscillate on and off the edge of the positive shell in a rapid movement causing medium size flickers of short duration.

When the positive has been advanced to position E in Fig. 5 the edge of the negative flame is permanently on the bottom side of the positive shell and the negative flame drives against the positive arc stream with a steady force of uniform direction and magnitude so that there is practically no flicker in the useful light from the arc. With the arc in this position, a high intensity spot lamp has been observed for half an hour at a time without detecting any noticeable flicker in the spot.

As shown in Fig. 6 the light is less for this position than in position D where some flickering is obtained. The light is still less in position F without any change in steadiness so that the position of optimum condition is that in which the edge of the negative flame impinges on the positive carbon as close to the end as possible without noticeable flickering on the screen or in the spotlight.

If the positive carbon is moved from position C or D to position E without changing the position of the negative or the ballast resistance and with line voltage held constant, as is often done in the projection booth, there might be an actual increase in light as well as the elimination of noticeable flicker. This effect would result from increasing arc current. Movement of the positive carbon in the opposite direction toward position A would decrease the light much more than is indicated by the solid line in Fig. 6. The variation of light with position under these conditions is indicated for a 115 volt power line by the dotted line in Fig. 6.

The distance from the projected axis of the positive carbon to the tip of the negative carbon for the arc illustrated in Fig. 5 is ⅝ inch. Similar experiments were made with distances of ½ in. and ¾ in. with exactly the same results. Within these limits and with the same relative position of the positive and negative flames the arc length had no noticeable effect on the useful light.

In the high intensity arc burning 16 mm. positives with an angle of 28 degrees between the carbon axes, it was found similarly that the position of maximum light was not that of maximum steadiness and that the edge of the negative flame definitely bathed the lower edge of the positive carbon when the light was most free from flickers.

In the beginning of the article mention was made that the determination

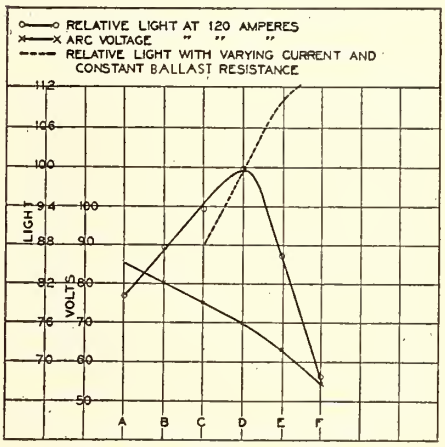


Fig. 6. Light intensity graph.

on the 13.6 mm. carbons were made at 110 to 125 amperes. 125 amperes is as high as we recommend that this particular size be used although many projectionists operate at 130 amperes and in some instances at still higher currents.

The carbon manufacturer is always glad of the opportunity to co-operate with the lamp manufacturer, the theatre manager, or projectionist on any problem involving the producing or application of light.

Acknowledgement is given to the *Journal of the Society of Motion Picture Engineers* for permission to use illustrations and data given in this article.

▲

STANDARD RELEASE PRINT

The establishment of the standard release print has made possible the abandonment of cue sheets for the projection of sound pictures, according to announcement of the technical bureau of the Academy of Motion Picture Arts and Sciences. Studios and exchanges have been notified by Lester Cowan.

Donald MacKenzie, member Board of Governors, S. M. P. E.

S. P. M. E. Convention

Peter Mole, Chairman, Pacific Coast Section S. M. P. E.

The spring meeting of the Society of Motion Picture Engineers at Hollywood, May 25-29 will have for presentation a large number of important technical papers, according to O. M. Glunt, chairman of the papers committee.

A LIST of the papers so far scheduled to be presented at the S. M. P. E. Convention follows:

"Detail in Television," by D. K. Gannett, American Telephone & Telegraph Company.

"Pioneer Experiments in Sound Recording," by Eugene Lauste.

"Baron Shiba Films." (These films were made in Japan and loaned to the Society through the courtesy of the Bureau of Standards. The pictures are made at a very high rate of speed and are projected so as to show in slow motion certain very high speed phenomena.)

"The Latin American Audience Viewpoint to American Films," by C. J. North and N. D. Golden, Motion Picture Division, Bureau of Foreign and Domestic Commerce.

"Technicolor," by J. A. Ball, Technicolor Motion Picture Corporation.

"Multicolor Process," by R. M. Otis, Hughes Development Co., Ltd.

"Multicolor Laboratory," by Bruce Burns, Hughes Development Co., Ltd.

"Comparison of the Technique of Making Two and Three Color Separation Negatives," by P. D. Brewster, Brewster Color Film Corporation.

"M-G-M Color Process," by O. O. Ceccarini, Metro - Goldwyn - Mayer Studios.

"Hand Coloring of Motion Picture Film," by Gustav Brock.

"Noiseless Recording," by H. C. Silent, Electrical Research Products, Inc.

"A Shutter for Ground Noise Reduction," by E. W. Kellogg and M. C. Batsel, RCA-Victor Company.

"Noise Reduction with Variable Area Recording," by B. Kruezer, RCA Photophone, Inc.

"The Ribbon Microphone," by H. F. Olson, RCA Photophone, Inc.

"A Moving Coil Microphone for High Quality Sound Reproducing," by W. C. Jones and L. W. Giles, Bell Telephone Laboratories.

"A Sound Film Reproducer for Re-recording Work," by J. J. Kuhn, Bell Telephone Laboratories.

"Recording, Re-recording and Editing of Sound," by Carl Dreher, RKO Studios, Inc.

"Recording Sound for Split Mat Photography," by L. E. Clark, RKO Pathe Studio.

"Sensitometry—Part I," by L. A. Jones, Eastman Kodak Company.

"Characteristics of DuPont Negative Film," by B. R. White, DuPont Pathé Film Mfg. Co.

"Characteristics of New Eastman Negative Film," by Emery Huse, Eastman Kodak Co.

"High Speed Oscillograph," by A. M. Curtis and C. H. Rumpel, Bell Telephone Laboratories.

"Improvements in Motion Picture Laboratory Apparatus," by C. E. Ives, A. J. Miller, and J. I. Crabtree, Eastman Kodak Company.

"Recent Developments in Thermionic Devices," by M. J. Kelly, Bell Telephone Laboratories.

"Sensitometry—Part II," by L. A. Jones, Eastman Kodak Company.

"Miniature Models of Sets," by Hans Dreier, Paramount Publix Corp.

"Use of Dialogue in Sound," by Colonel Joy, Motion Picture Producers and Distributors Association.

"The Depth of Field of Camera Lenses," by A. C. Hardy, Mass. Institute of Technology.

"Making a Motion Picture," by Paul Snell, Paramount Publix Corp.

"Universal Developing Machine," by J. A. Dubray, Bell & Howell Co.

"M-G-M Developing Machine," by J. M. Nickolaus, Metro-Goldwyn-Mayer Studios.

"Variable Area Processing," by D. D. Foster, Bell Telephone Laboratories.

"The Study of Exposure and Film Processing for Variable Area Recording," by E. W. Kellogg and G. L. Dimmick, RCA Victor Company.

"The Processing of Variable Area Sound Records in the Film Laboratory," by W. P. Bielicke, RKO Studios, Inc.

"Processing for Variable Density Records," by J. G. Frayne, Electrical Research Products, Inc.

"Analysis of Negatives," by L. A. Jones and C. M. Tuttle, Eastman Kodak Company.

"New Sensitometer," by L. A. Jones, Eastman Kodak Company.

"Two Special sensitometers," by B. R. White, Dupont Pathé Film Mfg. Co.

"Sensitometry—Part III," by L. A. Jones, Eastman Kodak Company.

"Directional Effects in Sound Film Processing," by J. Crabtree, Bell Telephone Laboratories, Inc.

"Straight Line and Toe Records with Light Valve," by D. MacKenzie, Electrical Research Products, Inc.

"Reducing and Intensifying Solutions for Motion Picture Film," by J. I. Crabtree and L. E. Muehler, Eastman Kodak Company.

"Electrolytic Regeneration of Motion Picture Fixing Baths," by K. Hickman, Eastman Kodak Company.

"Automatic Control of Electrolytic Recovery Apparatus," by K. Hickman, Eastman Kodak Company.

"Some Properties of Two-Bath Developers for Motion Picture Negative Film," by J. I. Crabtree, H. Parker and H. D. Russel, Eastman Kodak Company.

"The Dunning Process and Process Backgrounds," by C. H. Dunning, Hollywood, Cal.

"An Apertureless Optical System for Sound on Film," by R. C. Burt, R. C. Burt Scientific Laboratories.

"Continuous Non-Intermittent Projectors," by A. J. Holman.

"Properties of Low Intensity Reflecting Arc Projector Carbons," by D. B. Joy and A. C. Downes, National Carbon Co.

"An A-C Operated Sound Motion Picture Reproducing Equipment," by T. D. Cunningham, RCA Victor Company.

"Motion Pictures Screens," by F. M. Falge, Beaded Screen Corp.

"New Printing Machine," by O. B. DePue, DePue & Vance.

"Air Conditioning By Carrier Method," by A. H. Simonds, Carrier Engineering Corp.

"Air Conditioning," by E. C. Holden, Silica Gel Corp.

Apartment house antenna distribution system*

By E. V. Amy, J. G. Aceves and F. King

A multicoupler antenna arrangement which solves the problem of antennas for numerous receivers located in one building.

THE growth of the radio receiver industry has created an urgent demand for a radio wave distributing system for the operation of the innumerable radio sets in apartment houses and other large buildings in the great centers of population to supplant the individual aerial wires with their hideous appearance on the roofs.

The means of providing every radio set in an apartment house with the proper signal energy from broadcasting stations must be such that:

(1) It will supply sufficient signal strength well above any disturbing noises.

(2) It must permit the use of all commercial as well as special types of radio receiving sets.

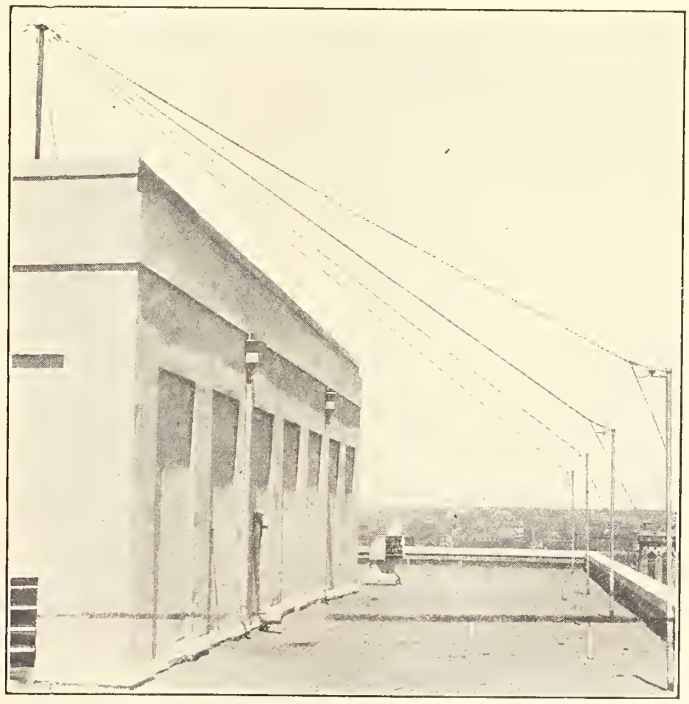
(3) The operation of one or more sets must not affect the performance of the other sets connected to the system to an extent that may be detected by any of the listeners.

(4) It must be simple and the cost of installation and maintenance must be low.

It is the object of this paper to show how the Multicoupler Antenna System fulfills the above conditions, as well as to briefly describe the theory of its operation and the practical development of the system for commercial installations.

There have been a number of attempts made to operate a plurality of radio receivers from one source of signal voltage. As soon as the vacuum tube was sufficiently developed as an electronic "relay" or repeater, some engineers used it as a coupling device of very high input impedance to transfer the signal voltage to the radio receiver. It was used also, or at least proposed to be used, for the purpose of obtaining a voltage amplification between the antenna and a two wire transmission line that would distribute the voltage to the individual coupling tubes. In connection with these tubes all kinds of selectors were proposed to be attached to reinforce weak stations and to obtain further selectivity in the radio receivers themselves. Such arrangements are too expensive and complicated.

Other attempts were made to operate radio receivers by means of conductors which existed in the building, such as gas and water pipes, heating systems, telephone leads and electric light circuits. The indoor type antenna became quite popular when sensitive sets were first developed commercially. Unfortunately, in all the latter cases there was present either one or all of the objections resulting from interference, noisy operation and generally unsatisfactory performance of the sets. To overcome all of these difficulties, a great deal of experimental and development work was undertaken by the writers. The idea of a single radio frequency line of distribution, without vacuum tubes or other apparatus subject to renewal and upkeep, was developed after many tests both in the laboratory and out-of-doors. The Multicoupler Antenna System of reception and distribution was evolved until it reached a very



Aerial arrangement to feed 200 apartments.

* *Delivered before the Radio Club of America, Feb. 16, 1931.*

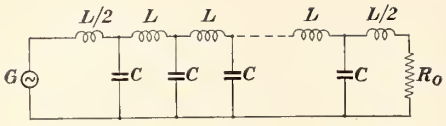


Fig. 1. Elementary coupler line.

satisfactory commercial stage, the theory of which will be given very briefly, as this paper aims particularly at the practical end and at the results of commercial operation for a period of about three years.

Theory of the Multicoupler Antenna System

It will be seen that the Multicoupler Antenna System consists essentially of a uniform attenuation line connecting a good antenna to a number of radio receivers, the line being connected to a terminal resistance at the other end. The signal voltage is supplied to the various radio receivers by means of multicouplers. The most elementary representation of a multicoupler line consists of a generator G, Fig. 1, which impresses an e.m.f. through an artificial line containing inductances L and condensers C to a resistance (R_o). The inductances and condensers have small losses and are such that $R_o=\sqrt{L/C}$. At all frequencies from 0 to $\omega=2/\sqrt{LC}$, the voltage will reach R with very small attenuation. The multicoupler, however, is not a filter section per se and does not act as such.

If, the resistances in series with the coils and in shunt with the condensers are of appreciable magnitude, the propagation constant per section will be

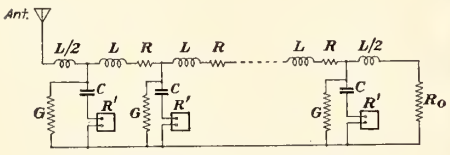


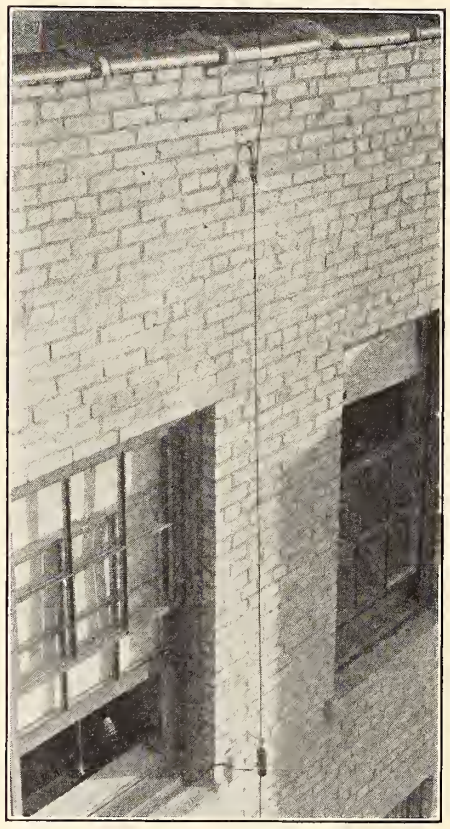
Fig. 2. Generator replaced by an antenna.

$P=\sqrt{(R+j\omega L)\ (G+j\omega C)}$ and the terminal impedance will be

$$Z=\sqrt{(R+j\omega L)/(G+j\omega C)}.$$

This line may attenuate the higher frequencies more than the lower ones unless ωL is large in comparison with R, and ωC with respect to G. Let us now replace the generator G by an antenna, and the line by a riser, Fig. 2, then the losses in the line may be considered as made of two components; one due to the series resistance of the conductors R′, and the other due to shunting conductances G representing dielectric losses and the energy consumed by the radio receivers R′.

This schematic representation is only a first approximation. The capacities C represent a combination of distributed capacity along the downlead and the coupling condensers. The conductance G also represents at the same time the losses due to the dielectric, leakage, etc., along the line, as well as the effect of the radio sets. If we make G small compared to ωC, and R small compared to ωL, the line will transmit the e.m.f. without appreciable attenuation, as previously stated, and the terminating impedance will be sensibly equal to $\sqrt{\frac{L}{C}}$. An approximation of theoretical conditions may be obtained by representing a section of the multicoupler line by means of a



Method of fastening head of downlead.

series inductance L, Fig. 3; a series resistance $R_1=f(\omega)$, which takes into account ohmic losses, eddy currents and skin effect; a shunt capacity C_1 with leakage resistance $R_2=\varphi(\omega)$, representing the dielectric losses and leakage; another resistance $R_3=\psi(\omega)$, representing a radio set, with the coupling condenser C_2 in series. The three resistances, which are functions of ω, may be expressed approximately as follows: $R_1=K_1\omega$, $R_2=K_2\omega^{.5}$ and $R_3=K_3\omega^{1.5}$. There may be some radio sets in which R_3 is independent of ω and some others in which $R_3=K\omega^2$ with tuned inputs; hence, we may assume $R_3=K_3\omega^{1.5}$ for an approximation.

The equations for the propagation constant per section obtained by introducing these functions of ω in the expression $P=\sqrt{(R+j\omega L)\ (G+j\omega C)}$ where $P=\alpha+jb$, from which the attenuation α may be obtained are rather complicated, and even after making the calculations the results would not be in close conformity with practice for the following reasons:

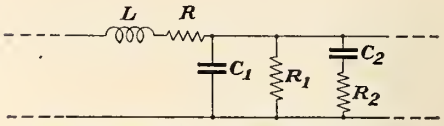


Fig. 3. Section of multicoupler line represented by an inductance.

In the first place, the radio receivers may have any values of resistance and reactance, which are variable according to the tuning condition.

Second, the shunt capacity is not uniformly distributed along the line and the losses due to eddy current, dielectric hysteresis, skin effect, etc., vary according to local conditions.

Third, it is assumed that the impressed electromotive force is applied to the beginning of the line. In practice, however, additional voltages are induced by the field of the broadcasting stations along the downlead. The manner in which these extra e.m.fs. are induced depends upon the surrounding medium. As there are so many buildings in the vicinity of the downlead, the pickup of both antenna and downlead varies in a very complex way—which cannot be predicted.

All these considerations lead to the experimental, rather than to the treatment a priori of the multicoupler line.

The most important properties of the Multicoupler Antenna System, or, in fact, of any common radio signal system of distribution, to be considered, are:

(1) The propagation of the signal from one end of the line to the other. This means the relative energy level at every outlet.

(2) The lack of interaction, if any, between radio receivers connected to the system.

(3) The actual signal strength at any outlet in comparison with individual signal collectors.

(4) The terminal impedance of the line and the prevention of standing waves along the line.

In connection with the last item, it is well to mention here that there are two types of multicoupler lines; the outdoor type and the conduit system. In the latter, additional distributed shunt capacity will be found and the terminal

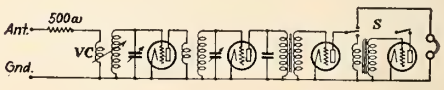


Fig. 4. Receiving system.

TABLE I

780 kc. Set No.	All Sets Tuned to 780 kc.	All Sets Completely Detuned	Detuned +1	Detuned −1
1	30	.....	.....	
2	24	.....	.....	
3	29	30.5	28	31
4	28	.....	.....	
5	31	.....	.....	

Potential distribution along line at input — 30
1 — 30.5
2 — 24
3 — 25
4 — 29
R — 28

1100 kc. Set No.				
1	35	.....	.....	
2	36	.....	.....	
3	37	42	33	29
4	34.5	.....	.....	
5	31	.....	.....	

impedance will be found to be lower than in the former, in which case, a suitable impedance-matching transformer is found very advantageous to connect the line in the conduit to the antenna as indicated in Fig. 8.

Propagation of the Signal

Two sets of signal strength measurements will be described:

(A) In the laboratory with a number of multicouplers to which sets are connected.

We have seen that one of the important requirements of the multicoupler line is that it should act as a uniform attenuation conductor for all broadcast frequencies. In order to verify this experimentally, a special receiving set was constructed, the schematic diagram of which is given in Fig. 4. In this set, the volume control VC, which is of the inductive (variable mutual induction) type, was calibrated in dbs. Additional range is obtained by means of a switch S permitting the use of one or two audio stages, the difference amounting to 15 dbs. and the total range about 60 dbs. With an "artificial" signal source made of an r-f. modulated by a single a-f. tone, a meter in place of or in addition to the head phones will permit a more accurate level determination. With actual broadcast signals, the meter will keep moving all the time and it is better to use the vanishing signal as reference level and note how many dbs. are needed to make the signal just inaudible. The more decibels the higher the level, and in the table of results the dbs. have this particular meaning.

Before the Multicoupler Antenna System was put in operation, in actual practice, a number of signal strength tests were made at the laboratory. The general layout is represented diagrammatically in Fig. 5. M, M_1 . . . M_n represent multicouplers all connected to an antenna of about 120 feet in total length at one end, and to a 1000-ohm terminating resistance. To the coupling condensers of the multicouplers were attached a number of radio sets, in many cases just equivalent tuned input circuits, LC, or mere resistances R_2, simulating commercial receivers equipped with or without "coupling tubes."

By means of this signal strength measuring set, the effects of the various radio receivers connected to a multi-

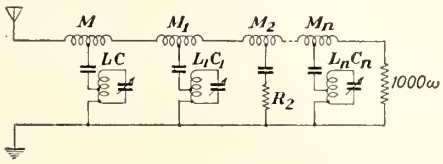


Fig. 5. Laboratory trial of Multicoupler System.

coupler line upon any particular one of them, can be determined experimentally. The actual procedure consisted in connecting to one of the multicouplers a radio set with a vacuum tube voltmeter across the speaker to indicate the volume of the signals received, which during the tests were either regular broadcast programs or locally generated modulated signals, the voltage of which was controlled by means of an attenuation resistance network calibrated in dbs. as shown in Fig. 6. When using this source of signal the measurements

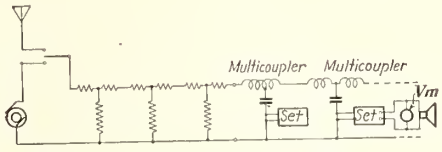


Fig. 6. Signal strength measurement.

could be made very accurately and expediently. All that was necessary was to maintain the reading of the vacuum tube meter constant while increasing or reducing the signal voltage by a given number of decibels. The results of the tests made under these conditions are given in Table I, where the first column gives the position of the set, starting from the antenna end. The second column gives the levels in dbs. at the various points along the line when the radio sets were all short-circuited or badly detuned, which has the same effect. The third column gives the same data but with all sets tuned, while the last two columns refer to conditions where the sets were very slightly detuned on each side. The last set of tests shows the effect of tuning at least half of the sets to one station.

The severity of the conditions under which the tests were made will never be found in practice. First of all, there was hardly two feet between outlets; then all sets were of the tuned input close coupling type with low-loss coils and condensers, and finally, the line was practically devoid of distributed capacity.

TABLE II

Floor	Station	Level for vanishing signal: Without transformer	Level for vanishing signal: With impedance matching transformer	Difference in level due to effect of the transformer
15th	WMCA	42 dbs.	58 dbs.	16 dbs.
	WEAF	38	50	12
	WABC	45	60	15
	WOV	37	57	20
12th	WMCA	46	55	9
	WEAF	40	48	8
	WABC	44	63	19
	WOV	34	54	20
9th	WMCA	43	55	12
	WEAF	39	50	11
	WABC	40	60	20
	WOV	37	53	16
6th	WMCA	43	59	16
	WEAF	40	52	12
	WABC	43	65	22
	WOV	41	58	17
3rd	WMCA	38	55	17
	WEAF	39	45	6
	WABC	45	60	15
	WOV	39	52	13

(B) In the field, in a building equipped with the Multicoupler Antenna System.

Similar tests were made later on an actual conduit installation at 770 Park Avenue, New York City. The portable set was carried to the third, sixth, ninth, twelfth and fifteenth floors of the seventeen story building and signal strength tests were made at four different frequencies. At the same time, the effect of an impedance matching transformer was determined upon the signal level at the same floors. Using the best ratio, the volume went up by an average of 15 dbs. Table II gives the results obtained.

These results are given in graphical form in Fig. 9. It will be noted how uniformly the propagation of the signal takes place along the line. The effect of the additional capacity due to the

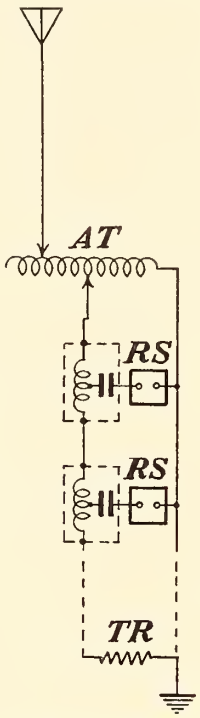


Fig. 8. Impedance matching with conduit system.

conduit lowers the impedance of the line to such extent that the transformer is found to be quite beneficial.

Interaction With Individual Antennas

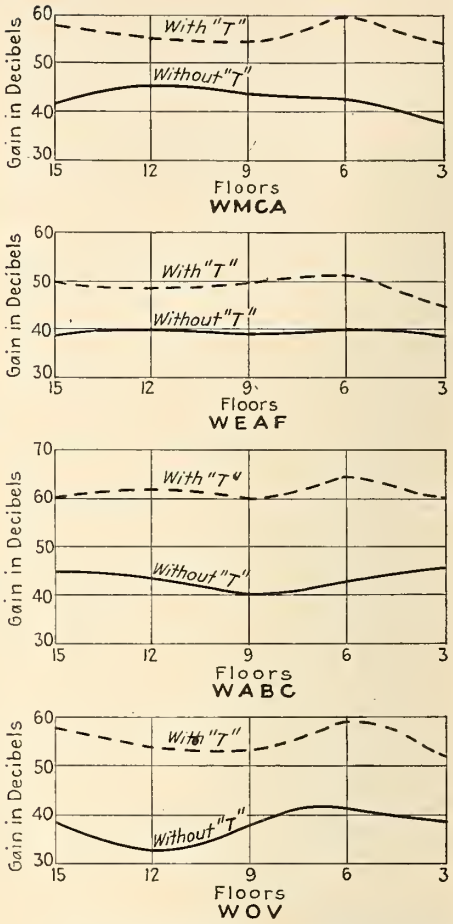
It is very interesting to compare the interaction between two sets when connected to the Multicoupler Antenna System or to individual antennas. For this purpose, two antennas five feet apart were brought down and sets connected to each one of them. The first set was of the tuned input type and the second one had means for measuring the volume in dbs. The two sets were connected successively to the aerial wires five feet apart and then to two consecutive multicouplers. The effects in the case of the multicoupler connection may be studied from data such as given in Table I under extremely adverse conditions. However, when the two sets were connected to individual aerials, the effect of tuning one of them to the station being received by the other was a level difference of between 5 and 20 dbs., according to the frequency and the sharpness of the tuning.

A signal, the strength of which does not vary by more than 1 to 2 dbs., is considered to be of constant volume from the listeners' standpoint. Five dbs. variations are noticeable only in comparative tests. A gradual fading of 5 dbs. can hardly be detected. With these premises in mind, it is possible to judge the performance of a multicoupler layout in the laboratory from tests made as described above. It must be remembered that these tests were made under the severe conditions described before.

TABLE III

Station	Energy Level: Multicoupler	Energy Level: Test Antenna	Gain in dbs. Multicoupler over Test Antenna
(At the ninth floor)			
WMCA.....	60 dbs.	30 dbs.	30
WEAF.....	60	47	13
WOR.....	60	47	13
WPCH.....	32	20	12
WABC.....	39	32	7
WAAT.....	42	18	26
WOV.....	53	53	0
1500 kc.....	13	58	—43
(At the fourteenth floor)			
WMCA.....	60	43	17
WEAF.....	60	43	17
WOR.....	60	44	16
WOV.....	60	44	16
1500 kc.....	40	14	26

In practice, in any of the buildings equipped with this system, there has not been as yet a single complaint on record of fading due to interference between sets, which may be looked upon as a favorable confirmation of the working theory. How is it then possible to reconcile two apparently mutually conflicting conditions, namely, sufficient signal strength, requiring large coupling condenser, and independence of operation demanding small coupling condenser? The results given above offer an answer but not an explanation. One explanation is as follows: The action that takes place with a multicoupler connected to a set is one of phase rotation rather than mere magnitudes of voltages. To make this clear,



EFFECT OF IMPEDANCE MATCHING TRANSFORMER UPON A CONDUIT MULTICOUPLER LINE

Fig. 9.

let us give some numerical values to the quantities involved. Let the multicoupler condenser have a reactance of say 900 ohms at a frequency close to the middle of the broadcast band. Assume the radio set to offer a pure resistance of 300 ohms when tuned to that frequency. The e.m.f. available from the antenna at the junction of the multicoupler condenser to the line will be across both condenser and set in series with each other and let it be of, say, one millivolt. The current supplied to the set would be

$$\frac{.001}{\sqrt{900^2 + 300^2}} = 10^{-6} \text{ amperes.}$$

If the set were detuned, its effective resistance and reactance would be very small and the current would be practically

$$\frac{.001}{\sqrt{900^2}} = 1.11 \times 10^{-6}$$

or only 11 per cent greater. Hence,

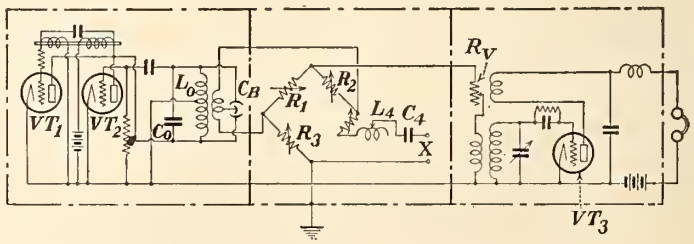


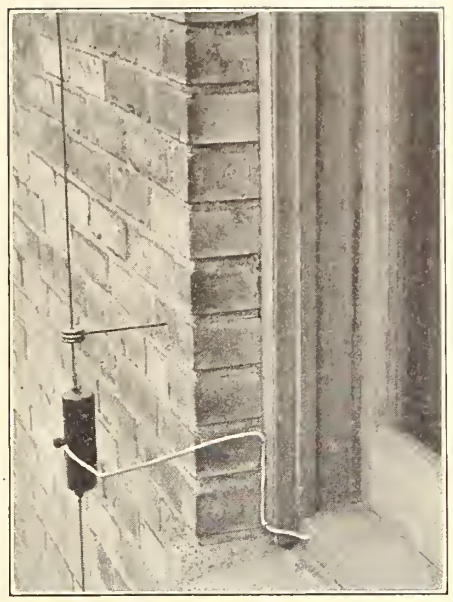
Fig. 7. Bridge method of determining terminal impedance.

the available voltage will still be substantially the same at all the other points in the line. The average set will offer a higher impedance to the line, so its effect on the signal will be less.

The signal voltage available to the set when tuned will be $10^{-6} \times 300$, or .3 millivolt which is about one-third of the total available potential from the riser. Hence, by cutting down the available voltage to 30 per cent the sets will become independent of each other. The phase rotations in the vector diagram offer the explanations of how the two conditions of sufficiency of signal voltage and freedom from interactions are fulfilled to a practical extent, without resorting to one-way repeaters, or coupling tubes.

Comparison with Individual Antennas

In order to find out experimentally how the signal strength from the multicoupler system compares with that obtained from an individual antenna, experiments were carried out at a 17 story apartment house. At the ninth and fourteenth floors successively, a standard set (Radiola, model 33, a-c.) with the volume control previously calibrated at the laboratory, was attached by means of a s.p.d.t. switch either to the multicoupler system or to a 40-foot outdoor antenna strung over an open court at the roof (seventeenth floor).



Detail of a multicoupler support outside rear window.

The average gain at the ninth floor was 14 dbs. ignoring the last reading which was no doubt the result of a standing wave formed in the individual aerial. The average gain at the fourteenth floor was 18 dbs.

These observations are typical of a larger number which for the sake of brevity, are not given, but they are enough to illustrate what has been found to be the case in all the Multicoupler Antenna installations — that there is plenty of signal voltage available at the antenna-ground posts of the outlet plates.

Terminal Impedance Measurements

In order to determine experimentally the terminal impedance of a multicoupler line, measurements were made on both laboratory layouts and in actual installations. These measurements were made by means of a portable Wheatstone bridge, the circuit of which is given in Fig. 7. The oscillator tube VT_2 has a balanced coil L_o so that one end is just as high above ground potential as the other end is below ground at the same instant throughout the a-c. cycles. The "figure eight" winding coils make magnetic induction very small. Besides, the aluminum double shield arrests the small leakage field that may be present. The oscillations are modulated by means of the audio frequency oscillator tube VT_1 which gives about 700 cycles. To prevent serious errors, a "Wagner earth" C_B is used to prevent capacity coupling interference in the operation of the bridge.

The bridge is made of four non-reactive variable resistances R_1, R_2, R_3, and R_4 from 0 to 200 ohms. In series with one of them there are; a variable condenser C_4 and a multistep inductor L_4. The condenser at the maximum capacity

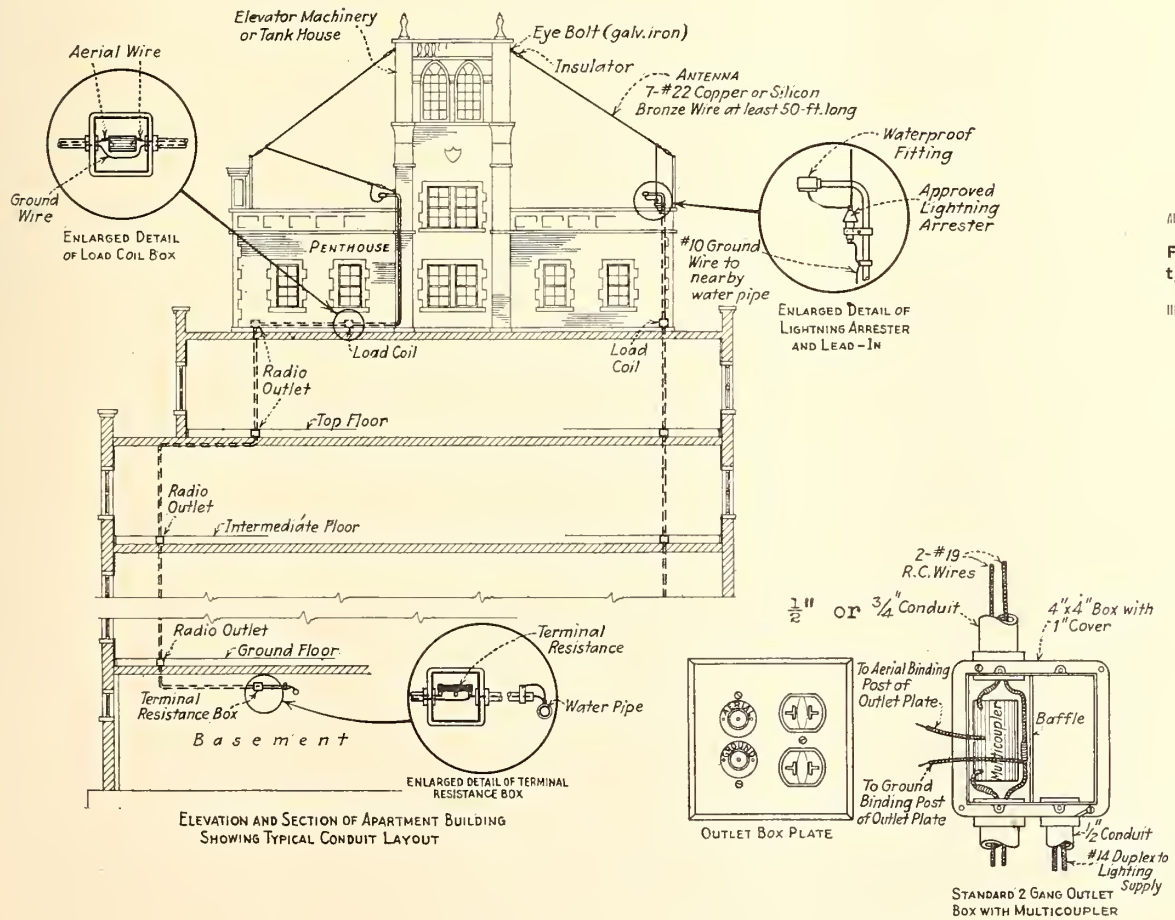


Fig. 10. Conduit type of installation.

setting will become short-circuited, and the inductor has four taps the first one of which puts it out; hence, both L_4 and C_4 may be put out of the circuit.

The unknown resistance may be connected between the resistance R_3 and the ground, or between the resistance R_4, condenser and inductor and the ground, so that in the first case the reactance will be balanced by means of a standard reactance of the same sign in the opposite arm, while in the second case the unknown reactance is neutralized by a known reactance of opposite sign in series with it, making the bridge non-reactive in all four arms.

The detector is a regenerative detecting tube with a tickler and a series resistance R_v in the primary to vary the sensitivity and help thereby to find approximately the balance settings. Once located it is easy to obtain an accurate balance by increasing the sensitivity of the regenerative detector. It is enclosed in its shielded compartment, and the tuning condenser has a scale calibrated in megacycles. The measurements with the bridge above described may be relied upon to be within 10 per cent or better.

In Table IV are given the results of the terminal resistance and reactance measurements at various frequencies of a setup of multicouplers with their condensers grounded and the line terminated by 1000 ohms. The same measurements were made on a conduit line in a commercial installation.

It will be noted that the impedances of conduit lines are much lower than those of the laboratory setup. There are several reasons for this which would take too long to enumerate. Better still to repeat that an impedance-matching transformer can raise the energy level by about 15 dbs. as seen before. The schematic arrangement is shown in Fig. 8.

The impedance of the multicoupler measured from the antenna and ground outlet to the radio set is approximately that of a .0003 mf. condenser. Thus it is evident that a set which will align properly on an antenna of this capacity, which is not much greater than that of an average antenna, will not be adversely affected by the impedance of the multicoupler.

The inductance of the multicoupler units is small enough so that the capacity of the downlead to ground furnishes enough capacity to make the operation satisfactory when only a few of the multicouplers in a long downlead are connected to receiving sets which are also connected to ground in the usual manner.

Practical Conclusions and Advantages

A large number of apartment houses in New York and other cities have already been equipped with the Multicoupler Antenna System and owners have been quick to realize that their radio antenna problem has been solved by this simple and inexpensive system, which may be installed by the average electrician or radio man.

The finished installation is neat, inconspicuous and exceedingly convenient for the apartment house tenant, as shown in the accompanying photograph of an outside installation in buildings already erected. The advantages extend to the set owner, since there are several benefits from this group antenna system and the multicoupler. First, each multicoupler is so designed that it serves to pass all the broadcast frequencies to reach the receiver. All interfering noises, such as electric motors, elevator contacts and so on, are reduced, resulting in a minimum of background noise. This arrangement also stands for greater selectivity and a much better quality of reception. Nevertheless, although adjusted primarily for broadcast frequencies, short-wave fans and television experimenters are not neglected in an installation of this sort. By connecting a small series condenser .0003 mf. to the main downlead, a few inches above the multicoupler, each tenant simultaneously secures the benefits of an excellent outdoor antenna for short-wave reception.

The multicoupler, with its coils and coupling condenser properly protected by a weatherproof case, contains nothing that can wear out. There are no tubes or other parts to replace. There is no further expense to this system once it is installed.

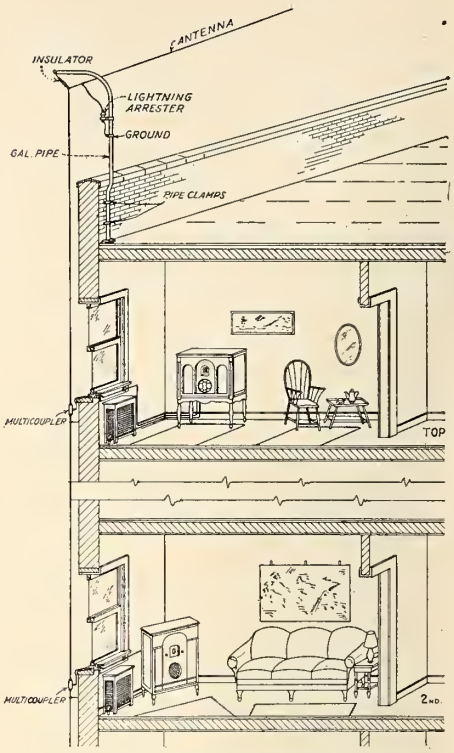


Fig. 11. Outside type of installation used on completed buildings.

The installation of the system in conduit in new buildings has proved equally as satisfactory as the outside system. Architects and consulting engineers are specifying the system as a standard feature in plans for new apartment buildings, apartment hotels, hospitals and dormitories.

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PUBLIC-ADDRESS AND SOUND ENGINEERING PROBLEMS

(*Concluded from page* 8)

a load equal to twice the plate impedance at 500 cycles. Thus if the plate impedance is 4,000 ohms, a transformer ratio of 3½ to 1 would be suitable, since in our problem the line impedance at 500 cycles is approximately 630 ohms. Under these conditions, there would be little distortion due to low plate loading up to at least 1,000 cycles. The power delivered to the line would increase gradually with frequency to a maximum at about 2,000 cycles. As before, a variable-ratio transformer might well be used until the most satisfactory ratio has been determined. The methods indicated, however, will give very satisfactory and economical results at both ends of the line.

It is frequently desirable to parallel a number of transmission lines. When this is the case, the lines may be treated as parallel impedance of the ordinary sort. *Characteristic* impedance values must be used.

TABLE IV

Effective resistance of a Multicoupler line containing 10 multicouplers with the condensers grounded and terminated by a 600 ohm resistance.

Frequency in megacycles	.6	.7	.8	.9	1.0	1.1	1.2
Effective resistance in ohms	640	525	453	420	400	385	375

Effective Reactance Negligible

Effective Resistance and Reactance of a Conduit Multicoupler Line with 17 outlets.

Frequency	.6	.7	.8	.9	1.0	1.1	1.2	1.3
Resistance	196	44	36	34	31	30	26	17
Reactance	—4	8	0	—6	3	—10	5	11

Examination questions for projectionists

Herewith is presented a list of guiding questions which applicants for grade A projectionist licenses in Canada are expected to be prepared to answer correctly

ALL projectionists, no matter where located, should study these questions. The information necessary to answer the questions may be gained from back issues of PROJECTION ENGINEERING, from instruction books and from J. R. Cameron's text books.

1. What are the requirements regarding construction of projection rooms?
2. What dimensions are required?
3. How must port-hole openings be covered or protected?
4. What area of ventilation is required for projection and rewind rooms, and where must vent pipes lead to?
5. What entrance and exits are required in projection room?
6. What is the fire fighting equipment required, and where must the units be located?
7. How often should port-hole shutters be tested?
8. What is the maximum footage of film permitted to be used on a standard 10 inch reel?
9. Where must all films be rewound?
10. How large a rewind room is required?
11. Where must all film not in the projector be kept?
12. What are the toilet requirements?
13. What effect will the placing of the projection room above the center of the screen have on the shape of the picture?
14. Is it advisable to place glass in observation ports, and if so, why?
15. How should glass be placed in observation port to avoid reflection?
16. What is meant by overloading a reel?
17. When should film be revised?
18. Would you use water on a film fire?
19. Should film be stored in projection magazine when not in use?
20. Describe the methods by which dry and brittle film may be cleaned and re-moistened.
21. What constitutes one reel of film?
22. Where should all films be rewound?
23. Why should both ends of the rewinders be in line with each other?
24. Where should all film scraps from repairs be placed, and give reasons?
25. What is meant by "pulling down" when rewinding?
26. Give nature of damage to film caused by "pulling down" film at rewinding?
27. Describe how to make a splice in film.
28. What are some reasons for film fires in projectors?
29. What will cause film to stop or pile up at the aperture opening or in front of the light beam?
30. What are the results of large film loops?
31. What damage may result from a wide, stiff or out-of-line splice?
32. What will unequal gate springs or traps do to the film?
33. If sprocket idler rollers are out-of-line or binding, what may happen to the film?
34. What happens to the film if the top magazine reel shaft is tight?
35. What film or other damage results from dirty magazine rollers?
36. Why are new prints waxed and old prints not?
37. What effect has overloading a reel on the film?
38. Why should a blank leader and tail piece be attached to each reel of film?
39. What is film buckling?
40. What will cause film to buckle?
41. What will the effect be on the screen if the film buckles?
42. What effect will an over scraped film splice have?
43. Name some causes for rain effect on film.
44. What causes corners of sprocket holes to become cracked?
45. Name several faults in a projector which will cause damage to a film.
46. Supposing a fire gets into top magazine what would you do?
47. What may cause film to jump sprockets?
48. Does the use of bent and broken reels damage film, and if so, how?
49. How is the speed of reels in magazines regulated?
50. What is the cause of flicker?
51. When the picture size is increased, without other changes, will there be apparent loss of light on the screen?
52. What harm results from dirty sprockets?
53. What causes white streaks both up and down from letters or titles?
54. What causes emulsion to collect on the aperture shoes and what damage may it do?
55. What will cause film to have an up and down movement on the screen?
56. What causes film sprocket holes to be pulled or broken out at the sides?
57. What is a mis-frame?
58. What would you do in the event of the projector binding up?
59. Of what use is film gate tension and how would you adjust same?
60. Name the parts and function of the intermittent movement.
61. What is travel ghost? Tell how to correct it.
62. If a decided flicker is noticeable at a speed of 90 feet a minute, what can be done to lessen the flicker?
63. What damage is caused by overtight magazine take-up tension and how can it be overcome?
64. What causes loss of lower loop?
65. Describe the various parts of the projector that are provided for fire prevention.
66. What would cause the intermittent sprocket to stand still while the rest of the projector mechanism is in motion?
67. What are the uses of the idler rollers and what is their proper adjustment?
68. Explain purpose of film gate idlers.
69. What purpose do film gate tension springs serve?
70. What effect on the picture image will worn aperture plate tracks have?
71. What is the requirement for the fire shutter on projectors?
72. Why is a revolving shutter used on a projector?
73. What will cause hooked sprocket teeth?
74. What would you use to clean the projector after an aperture fire?
75. Can and should sprockets be reversed when they show wear?
76. Which make of a projector has

an actual faster movement, that is, the movement of the intermittent from full rest to full rest?

77. What is the star?

78. What is the cam?

79. What is the intermittent sprocket?

80. What damage may out-of-line sprockets cause?

81. Why are fibre gears used?

82. What advantages are there to gears that are spiral cut?

83. What is the aperture plate?

84. How tight should aperture tension be on new film?

85. Why should aperture tension be varied on new and old film?

86. Should there be slight end play in film idlers?

87. What is the standard aperture size?

88. What damage will excess oil cause?

89. What factors decide the size of lens required?

90. Name some causes of out of focus effect.

91. How would you adjust the optical system to obtain a clear field of light on the screen?

92. How far apart should condensor lens surfaces be spaced?

93. Why are the curved surfaces of condensors placed next each other?

94. Suppose you could not move the lamp-house or lamp nearer the aperture, what can you do to get a clear white light on the screen?

95. What is a light ghost?

96. What will cause a brown streak on one side of the screen?

97. How can the spot at the aperture be enlarged?

98. What will be the effect on the picture of a badly pitted and dirty condensor?

99. Give some causes of condensor breakage.

100. Why does a cracked condensor show up when using slides and not when using film?

101. What sizes of condensors are generally used?

102. What is reflection of light?

103. What is refraction?

104. What is the optical axis?

105. What is chromatic aberration?

106. What is spherical aberration?

107. What is working distance of a lens?

108. What is lens diameter?

109. What is keystone effect?

110. How can keystone be overcome to a certain extent?

111. Knowing size of screen and projection distance, how would you find size lens necessary to give a required size picture?

112. What is absorption of light?

113. What is the optical system of the projector?

114. What is meant by the focal length of an ordinary projection lens?

115. What is used to cement lenses together?

116. Why should the inside of the lens barrel be painted flat black?

117. How should the various elements of a projection lens be assembled?

118. What effect have dirty projection lenses on the screen image?

119. Should projection lens be held tightly in the mount, and if so, for what reason?

120. How would you measure the focal length of a condensor lens?

121. What is meant by equivalent focus of a projection lens?

122. How could you test a lens for distortion? (By this is meant, how can you prove that your lens will give a complete sharply focussed picture?)

123. How could you measure the working distance of any projection lens?

124. In changing from a lens of small diameter to one of large diameter, what change might be necessary in the shutter blades?

125. What is meant by front and back factors of a projector lens?

126. Why is the diameter of the projection lens of great importance?

127. Define flicker.

128. Define a condensing lens.

129. Define collector lens.

130. Define converging lens.

131. Define plano lens.

132. Define plano convex lens.

133. Define meniscus lens.

134. Define a volt.

135. Define an ampere.

136. Define an ohm.

137. Define a watt.

138. Define a kilowatt.

139. Define a horsepower.

140. Define ohm's law and state how it works.

141. Define direct current.

142. Define alternating current.

143. Define a cycle.

144. Define an alternation.

145. Define a megohm.

146. Define electric current.

147. Define a short circuit.

148. Define a ground.

149. Define an electric arc.

150. How can the "size" of a wire be measured?

151. What necessary appliances does 110 v. d-c. pass through from the main switch until it reaches the arc?

152. What governs the size of wire used on any circuit?

153. What is a two-wire circuit?

154. What is a three-wire circuit?

155. What will cause a wire or terminal to heat up?

156. Show by diagram two arcs connected to a 110 v. two-wire circuit.

157. Show by diagram two arcs connected to a 110-220 v. three-wire circuit.

158. Show by diagram balanced load of two arcs, two motors and two rheostats on a three-wire 110 and 220 volt line.

159. Why is the neutral of a three-wire system grounded?

160. Why does the power company prohibit fuses on the neutral wire?

161. What type of covering should be used on wires that lead to the arc lamp?

162. What is meant by resistance wire?

163. What is meant by the negative wire of a d-c. circuit?

164. What is meant by the term "open circuit?"

165. What is meant by the term "closed circuit?"

166. What is the neutral wire of a 110-220 v. circuit?

167. What is meant by the safe carrying capacity of a wire?

168. What does the term electrical conductor mean?

169. With tight connections and good insulations, what will cause wires to overheat?

170. What insulation is used where wires pass through the lamp house?

171. In what position should a switch be pulled to open the circuit?

172. How would you determine the voltage on your line?

173. What protection is required for knife-switches?

174. Should wires have terminal lugs where they are connected to switches?

175. Why should all connections be kept clean and tight?

176. Describe the method of making a joint or splice in a wire.

177. Why are some starting switches on motor generators and larger equipment enclosed in oil?

178. What is a live wire?

179. How are tubes used as amplifiers?

180. What does polarity mean?

181. Why is d-c. used more than a-c. on projection arcs?

182. Why is a-c. used more than d-c. in commercial work?

(*To be continued*)

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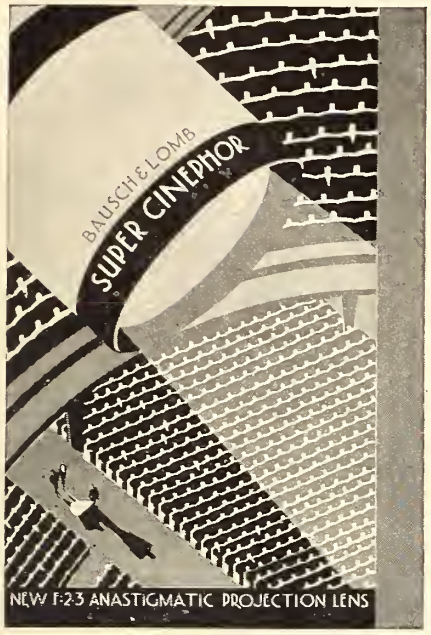

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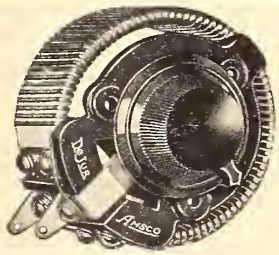

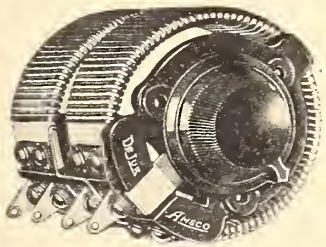

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New Developments and News of the Industry

W. H. HUTTER WITH CAPEHART CORPORATION

Of interest to the trade is the announcement that W. H. Hutter, formerly chief engineer of the Webster Electric Company, Racine, Wisconsin, has become associated with The Capehart Corporation, Fort Wayne, Indiana.

In his new connection with Capehart, Mr. Hutter is chief electrical engineer and in charge of manufacturer's division sales. He brings with him long experience in audio and acoustic research, and will concentrate on the more intensive development of tone quality for the Capehart line.

For the past twenty-five years, Mr. Hutter has specialized in audio and acoustics and during that time has served as consulting engineer in an advisory capacity to many companies engaged in radio production.

His early training was with the American Telephone and Telegraph Company in the field of acoustics, audio research and public-address work. While with them he conducted and developed original design in electric pickup construction.

▲

PROJECTOR CARBONS

Another important improvement in projector carbons is announced by National Carbon Company, Inc. This is the "pre-cratering" of 9 mm. x 20-inch National high intensity projector carbons. Pre-cratering, as the name implies, consists in forming a crater at the burning tip of the carbon during the process of manufacture. In addition to the pre-cratered tip, the holder end of each carbon is beveled to permit easy insertion in the holder jaws. All 9 mm. x 20-inch high intensity carbons now leaving the factory embody these improvements.

Pre-cratering gives better initial performance of the carbon in two respects. It results in clean burning when the arc is struck on a new carbon and it reduces the time required for the arc to burn in. Every projectionist will appreciate the importance of these features.

▲

PANEL MOUNTED AMPLIFIERS

The General Amplifier Company, 27 Commercial Avenue, Cambridge, Massachusetts, announces a new line of panel amplifiers embracing several different types of rack mounting. This new line consists of microphone amplifiers, voltage amplifiers, and several types of output amplifiers, ranging in power output from 5 to 50 watts. These amplifiers are constructed on a quarter-inch steel panel finished in black crackle. They are of quality construction throughout, and very ruggedly made. They were primarily designed for the utmost in sound reproduction.

▲

NON-THEATRE SOUND INSTALLATIONS

In addition to having broken all records for the sale of sound apparatus for theatre installations during the past sixty days, RCA Photophone, Inc., has increased its activities in the non-theatrical field to a marked degree. The largest single order for sound apparatus ever placed by the authorities of a state was received yesterday by Sydney E. Abel, general sales manager of RCA Photophone, Inc., from the department of business control of the State of Washington. Four complete units of sound reproducing apparatus were ordered for the Washington State reformatory at Monroe; the Washington State penitentiary at Walla Walla; the Eastern State hospital at Medical Lake and the State training school at Chehalis. F. W. Normand, district manager of RCA Photophone at Seattle, negotiated the contracts. Mr. Abel said it was the intention of the Washington state authorities to install sound apparatus in every large state institution and that the contracts for the installation in the four institutions mentioned came after Messrs. Olsen and McKibben had seen and heard various types of apparatus demonstrated.

▲

LIGHT VALVE CONTROL

The Enterprise Optical Mfg. Company, 564 West Randolph Street, Chicago, Ill., for the Motiograph De Luxe Sound equipment employs an ingenious light valve control for the regulation of sound level. This is accomplished by controlling the amount of light falling on the light sensitive surface of the photocell. It is stated that by its use the fader device may be eliminated from the audio circuit.

▲

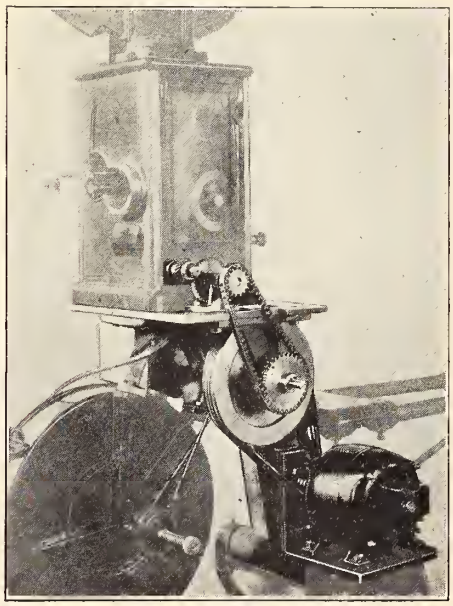
SOUND EQUIPMENT

Jenkins and Adair, Inc., 3333 Belmont Avenue, Chicago, Ill., have issued bulletin 1E, illustrating a line of transformers, retards, gain controls, mixing controls and amplifier accessories. Bulletin 13 A describes a new monitor panel, and bulletin 14 A, a portable amplifier and portable mixer.

▲

NEW SOUND HEADS

The Weber Machine Corpn., 59 Rutter St., Rochester, N. Y., announces a new synchrofilm unit for Motiograph de Luxe projectors. The illustration shows the drive.



HOME TALKING PICTURES

The Visionola Mfg. Corporation, 60 East 42d Street, New York, is having outstanding success in marketing the Visionola, a home talking picture outfit. The projection equipment, sound reproducer and screen all are mounted in one cabinet unit.

▲

NEW AMPLIFIER EQUIPMENT

Five items of associated equipment especially designed for use with AmerTran series 80 power amplifiers have just been announced by the American Transformer Company, 178 Emmet Street, Newark, N. J. The new equipment is also arranged so that it may be used with other standard amplifiers having 500-ohm input circuits. The various units available are as follows: Master control, Type C-81; master control with one-stage pre-amplifier, Type A-88; two-stage, low-level input amplifier, Type A-89; "A" power supply unit (12-volt), Type P-78; and dynamic field supply unit, Type P-101.

It is the function of master control Type C-81 to control volume, to select signals from a 500- or 200-ohm source, and to regulate operating current to the 200-ohm source. The volume control is a 500-ohm constant-impedance, T-pad attenuator and the output impedance is 500 ohms. The Type A-88 master control with pre-amplifier is identical to Type C-81 except a one-stage, low-level amplifier is connected in the 200-ohm input circuit.

Input amplifier Type A-89 is for raising low-level signals to values sufficient for exciting the main amplifier. It employs two transformer-coupled stages utilizing d-c.-operated 227-type tubes and has an output impedance of 500 ohms. It is available with a high-impedance or 500-ohm impedance input and is supplied in a compact metal case designed for wall mounting.

Power supply unit Type P-78 has been designed to provide filament current for AmerTran d-c.-operated amplifiers, such as Type A-89. It has an output of 12 volts filtered d-c. at 1.75 amperes and operates from 110-volt, 60-cycle lighting circuits. Power supply Type 101 is of similar design but provides an output of 7.5 or 15 volts at 1.5 amps. It will energize the fields of one or two dynamic loudspeakers.

▲

AMPLIFIER EQUIPMENT

The Polymet Manufacturing Corpn., 829 East 134th Street, New York, has issued bulletin Amp-1 illustrating and describing a new and up-to-date line of main and head amplifiers for sound installations.

The company manufactures a standard line of condensers, resistors and chokes.

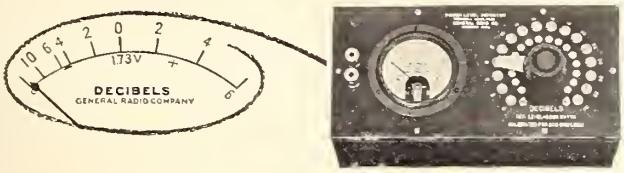
The equipment is being marketed in complete panels and in kits.

▲

"QUEEN" DIRECT-READING OHMMETERS

An improvement over existing types ohmmeters with slide as rheostat of Wheatstone bridge thereby giving uniform scale. Ratios 0.1, 1, 10, 100, 1000 and 10,000 with ranges from fraction of an ohm to 2,700,000 ohms. Operation consists only of closing keys and rotating scale index for balance. These are made by The Gray Instrument Co., 64 West Johnson St., Philadelphia, Pa.

DIRECT READING



TYPE 586 Power-Level Indicator

An open clearly marked decibel scale makes the General Radio TYPE 586 Power-Level Indicator a truly direct-reading instrument. The time saved and the freedom from costly mistakes such a scale insures are advantages readily appreciated by the monitoring operator in the broadcast and recording studio.

If you are not familiar with this instrument, a request on your business letterhead will bring you a catalog description. Please ask for Bulletin 932-P.

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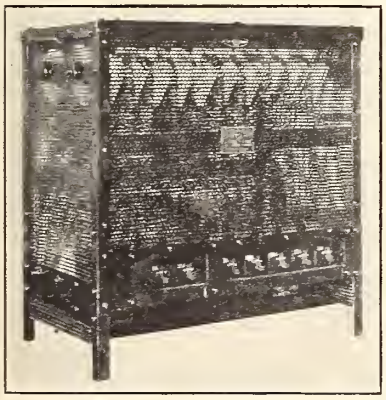

ONE OF THE PIONEERS

The motion picture industry is a strong chain composed of many links. Each link represents a branch and is the result of years' experimental and research work put forth by pioneers in this great industry. HOFFMANN-SOONS is one of the links that forms this chain and has played an important part in the building up of this enormous institution.

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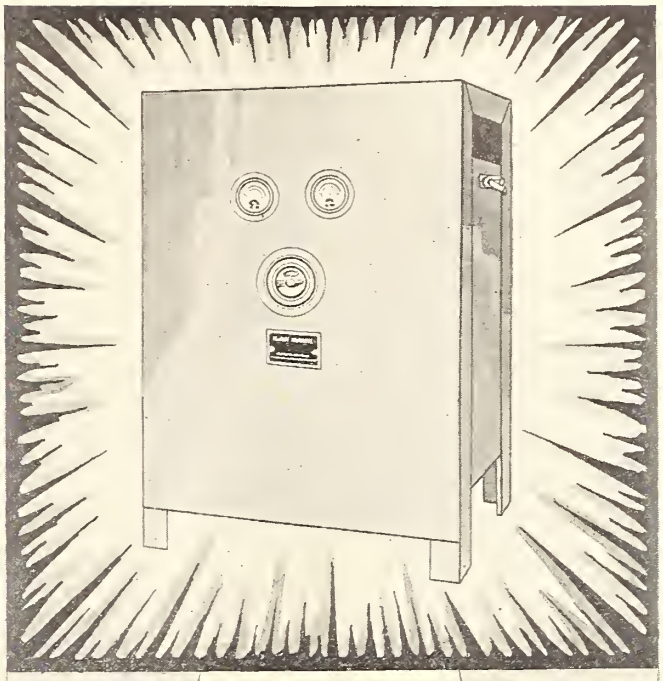


FOR

GOOD PROJECTION

Forest Rectifiers are designed and constructed to meet the need for dependable rectification equipment. They are silent, and may be operated in the projection booth with sound apparatus.

The Forest M.P. 25-25 Rectifier, illustrated above, supplies steady, direct current of from 15 to 25 amperes to two projectors continuously.

All Types of Rectifiers in 15 amps., 25-25 amps., 30, and 65 amps., Sizes

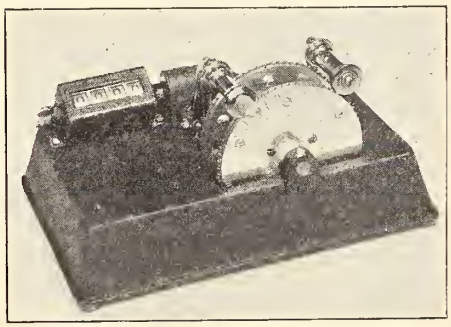
Write Today for Literature!

Forest Electric Corp.
New and Wilsey Sts., Newark, N. J.

FILM MEASURING MACHINE

Theatre Engineering Service Co., Ltd., of Hollywood, Calif., announce their new T.E.S. Precision film measuring machine, which has many desirable features, among these being a heavy cast-iron base with rubber feet, allowing the machine to be placed on a work-bench and film measured without the annoyance of the machine moving during this process.

This new measuring machine has a large 64-tooth sprocket constructed of duralumin; and, although this sprocket is twice as large as those generally used, the weight has been kept to an absolute minimum, making starting and stopping much easier. The sprocket is supported on two bearings, and is directly connected to the counter, thus eliminating all gears. Frame numbers are engraved on the edge of the sprocket. The base and the sprocket are so constructed that when the



machine is placed over a light on the work-bench, it permits of the frame lines being distinguished without removing the film from the sprocket. The counter is placed at a 30-degree angle, making it easier to see at all times.

The base is finished in black crystal-lac enamel, while all other parts are nickel-plated.

T.E.S. Precision film measuring machines are being distributed throughout the United States through the National Theatre Supply Co.

▲

HOME TALKIES

Oroscope is the offering of the Oro-Tone Company of Chicago. It is a self contained combination radio-phonograph-home talkie, projecting either silent or sound pictures and adjustable for 78 or 33⅓ r. p. m.

▲

AMPRO TALKER

Ampro, is arranging for a New York demonstration of its new talkie projector, which is designed for industrial and educational fields.

▲

STEWART WARNER EXPANSION

Stewart Warner Company of Chicago has progressed from speedometer, then radio manufacture, and will now follow with the production of an amateur movie camera with the manufacture of a projector.

▲

TWO PHOTOLYTIC CELLS DEVELOPED BY ARCTURUS

Two new Photolytic cells, designated as Type P-23 and P-27 and designed especially for use in equipment where space is limited, yet maintaining the photo-sensitive area, have been placed on the market by the Arcturus Radio Tube Co. of Newark.

Because of the ruggedness and principle of the photolytic cell, these units are non-microphonic and require no polarizing potential, the company claims. Background noise is eliminated and because of the extremely low impedance of these cells there is no pickup of parasitic noises. The high sensitivity of these cells provides an exceptional audio frequency response which is characteristic of the Photolytic principle, it is said.

A new folder describing the complete line of photolytic cells has just been issued by the company.

EASY WAY TO ADJUST SIMPLEX REAR SHUTTER

A practical and simple method of determining when the rear shutter on the new Simplex machine is in a neutral position, has been worked out by Max Silverman, projectionist.

Ever since these machines were introduced, operators have had difficulty in placing the shutters in the neutral position. It has necessitated much trying to get the pilot light in just the right position, and then experimenting until the neutral position was found.

Following is the method which Silverman worked:

There is a shaft that protrudes from the front of the machine where the original shutter was held in place. By the easiest means practical, place the blades of the rear shutter in a neutral position. Then with white paint make a little arrow on the hub of the shaft in front. This arrow will at all times indicate the position of the blades of the rear shutter, and when the arrow is directly in front the blades will be in neutral.

▲

RCA PHOTOPHONE ABROAD

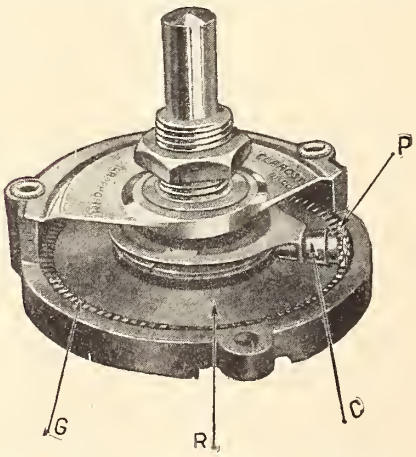
Patrons of motion picture theatres in England, France and Italy are more particular about the quality of sound reproduction than are the patrons of theatres in the United States, according to M. C. Batsel, chief engineer of RCA Photophone, Inc., who has just returned from a five weeks' business trip abroad. American made pictures are the backbone of the industry in each of those countries, although local producing corporations are beginning to become more active. With one exception, seven of the eight large studios in England record by the RCA Photophone system and the two principal studios in both France and Italy employ the Photophone method.

"The installation of sound reproducing apparatus in the motion picture theatres of England, France and Italy is progressing rapidly with a definite demand for equipment that will deliver sound of high quality," said Mr. Batsel. "The people have become sound conscious and as a result inferior sound apparatus is being replaced. Theatres which do not offer good sound are empty and those that have good sound are enjoying excellent patronage. In Italy the demand is for quality musical sound reproduction. A well-scored picture will play to good business. A poorly scored picture will starve."

▲

VOLUME CONTROLS

The Clarostat Manufacturing Company, Inc., 285 N. 6th Street, Brooklyn, N. Y., offers a graphite unit which includes a positive rolling contact. A rotating movement is given to the roller contact (c) by means of a small pinion (p) attached to the contact roller, engaging gear track (g)



moulded in the periphery of resistance element (r). Turning the knob imparts a rotary motion to the contact arm. A smooth, positive contact is assured over the length of the resistance surface.

NEW PORTABLE RECORDER DEVELOPED BY RCA PHOTOPHONE

A new portable sound recording equipment for use in connection with the Mitchell camera, and designed for greater efficiency in location and newsreel work, has been produced by RCA Photophone in collaboration with Westinghouse and General Electric. Entire equipment weighs less than 400 pounds.

A feature of this apparatus is the adoption of the single system of recording by means of which the sound is recorded upon the film 19½ frames in advance of the exposure of the picture, which makes possible the immediate reproduction of the subject after it has ben developed and printed.

▲

A HORN FOR PUBLIC ADDRESS

A new two-unit, six foot trumpet is announced by the Racon Electric Company, 18 Washington Place, New York, which will find wide application in the public-address and sound field. It has a 30-inch bell, round, length 54 inches. It has a metal beaded edge, cast aluminum throat section,

loose coupling for units, and is demountable. It is equipped to operate with two units. The weight is 23 pounds.

▲

POTENTIOMETERS

The DeJur-Amsco Corporation, 95 Morton Street, New York, state that the electrical features of that company's heavy duty rheostats and potentiometers are made possible by refinements in mechanical structure. The resistance wire is wound over three layers of .015 inch (per layer) asbestos covering on a steel core. The anchorage is permanent and of low electrical resistance.

The Alleghany metal arm is of special design, providing an unwearing pressure upon the resistance wire of ten pounds to the square inch. The contact between the bushing and the contact arm is under a constant pressure of twenty pounds, and the current is carried both by the bushing and the shorted-out section of the rheostat, with the definite elimination of microphonic effects associated with resistance variations in ordinary rheostats.

▲

BEACON PROJECTOR

The Beacon projector, manufactured by the Beacon Projector Co., 521 West 57th Street, New York, is equipped to take standard size 35 mm. film. The Beacon standard lighting equipment is a 300 watt —110 volt projection lamp and the motive power is a 110 volt universal motor taking either direct or alternating current. Equipment for use with a 32 volt farm lighting circuit or an automobile storage battery can be furnished. The Beacon is also equipped with a hand drive.

▲

FILM REELS

A new series of sound film reels is being marketed by the Universal Electric Welding Co.

These reels are spot welded, have no brazing screws, clamps or paint. Sizes vary from 16mm. to 70mm. in 1,000 and 2,000 foot capacities.

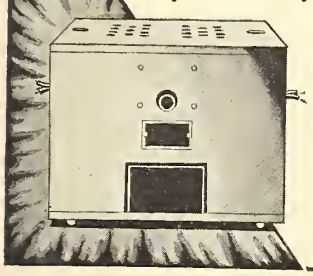
Aside from their rugged construction and light weight, the reels are designed to offer the least film friction, thus adding long life to the print by eliminating possibility of film damage.

No hum, noise or moving parts...

FOREST RECTIFIER

Leading Sound Recording Studios, Theatres, and Laboratories where unfaltering current supply is required use FOREST—because it is superior.

Adaptable to all sound equipment—interchangeable with your present storage battery—several types.



Just turn the switch to convert a 110 or 220 v. a-c. into fully filtered d-c.

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CINEGLOW

the 3 element recording lamp

(patents pending)

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For Optical or Contact Slit.
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For Any Standard Glow Lamp Circuit.

CONSISTENT — RELIABLE

Maximum Volume—Abundant Exposure—Without Distortion

Special circuits supplied with each lamp.

PRICES

Type T9 — 6 inches long — $50 each
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Special discounts in quantities.

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CLAYTON Even Tension TAKE—UP

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The Clayton *Even Tension* Take-up assures absolute freedom from flutter. It takes up any amount of film evenly. It will take up with any size reel hubs. It prevents excessive wear on the lower take-up sprocket and shaft. It stops the opening of film splices and prevents excessive wear on the film.

Write for price and further information.

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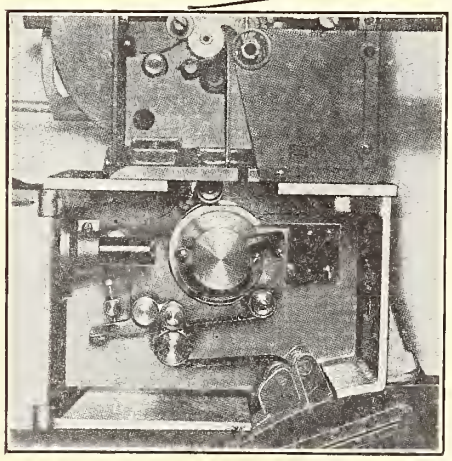
"SYNCROFILM"

PERFECTION IN SOUND-ON-FILM REPRODUCTION---NO FINER SOUND SYSTEM IS OBTAINABLE AT ANY PRICE!!



No Friction on Film; Steady Drive; Patented Light Beam Optical System .0005 Wide, High Intensity.

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The truly perfected single button hand microphone. Two models, "Regular" and "Special Home Recording." Scientifically damped diaphragm, gold plated button, toggle switch, 15-foot cord. Finished bronze or gunmetal. Dealers, write for our "direct deal." Get our complete catalog.

No. 1275 Transformer
Input transformer designed for any single button microphone. 200 ohm Primary, 100,000 ohm on secondary side. List price $5.

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Microphones $5 to $350. Also cables, plugs, transformers, mountings, stands, etc. Expert microphone repairs.

Portable Sound Distribution Equipment

For schools and colleges, churches, lodges, parks, airports, etc. Output sufficient for two dynamic speakers at heavy volume. Completely equipped with meters and controls. Padlocked against tampering.

Dealers can rent this equipment profitably.

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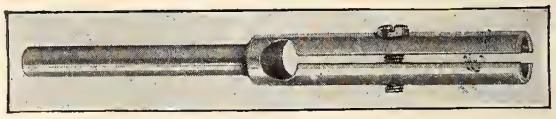

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Permits projectionist to get at least one more reel from each set of stubs. Made in 7, 8, 9, 10, 12 and 13 mm. sizes.

$2.50 each at your dealer.

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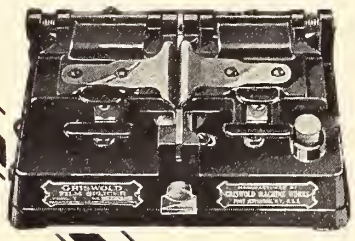

We build splicers to your specified requirements—for sound film, wide film, 35mm or 16mm film. Our splicers, both standard and custom-made, are giving sturdy, dependable service in theatres and exchanges throughout the world.

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Invigorating breezes from ocean on East and Lake Holly on West.
Bright, airy outside rooms, parlor suites and apartments, private baths, superior cuisine—Surf bathing, riding, fishing, golf, dancing, private tennis court and children's playground.

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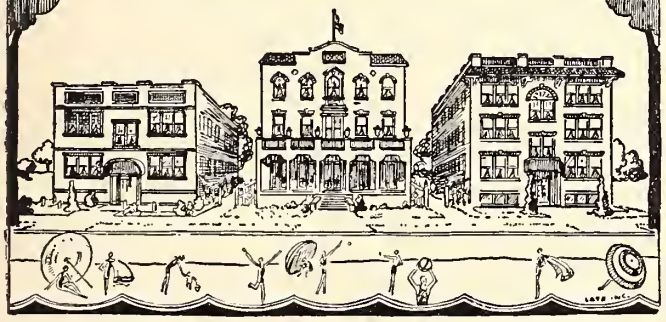

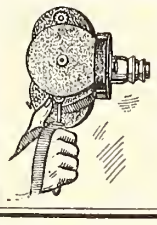

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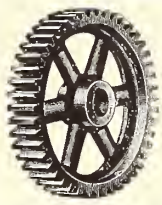

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place at your disposal their laboratory facilities for your assistance in volume control problems.
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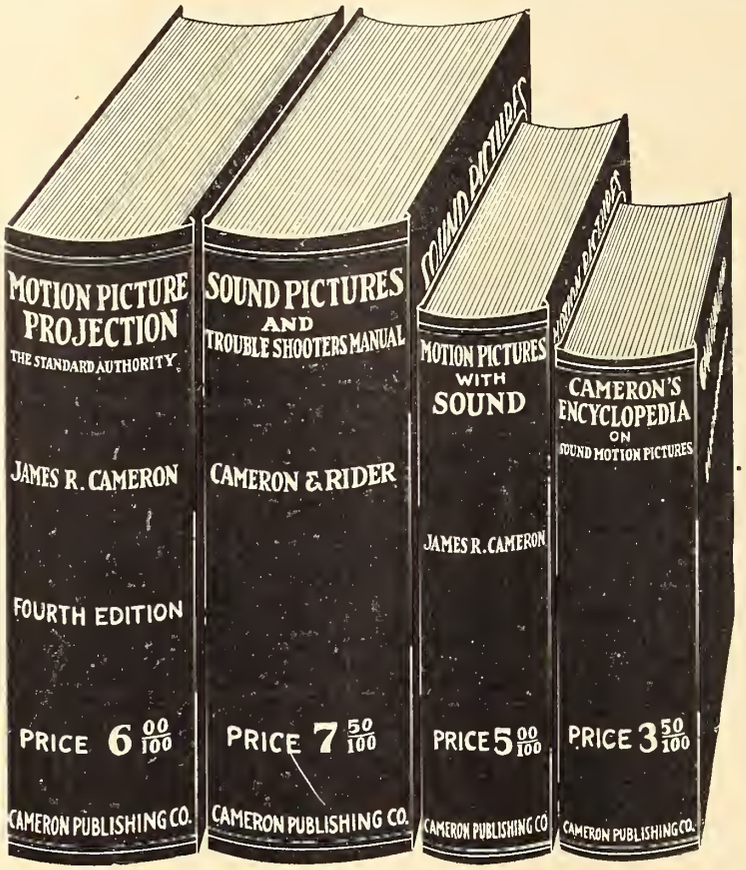

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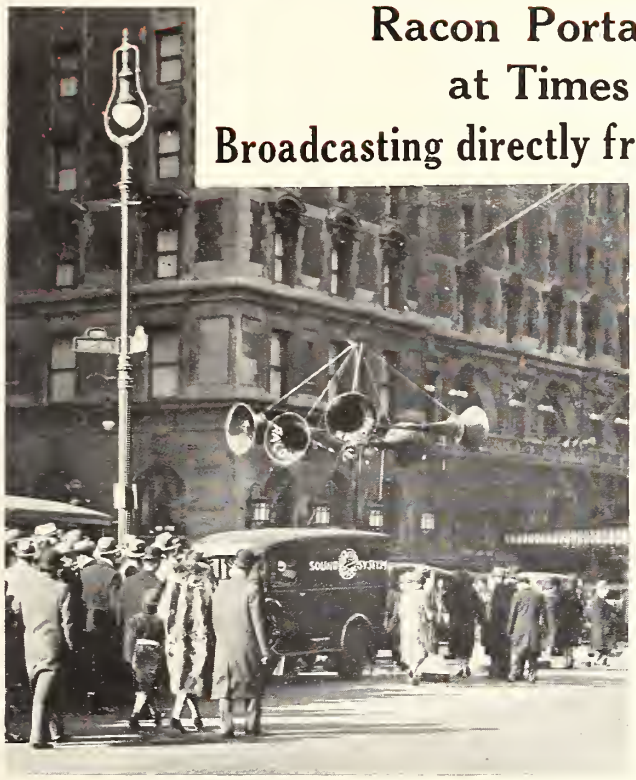

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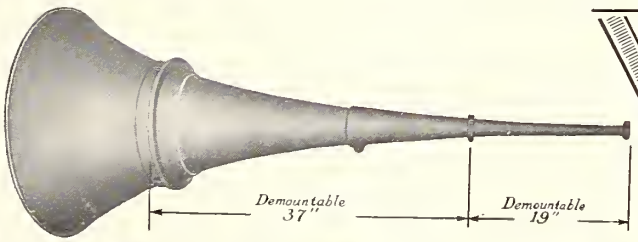

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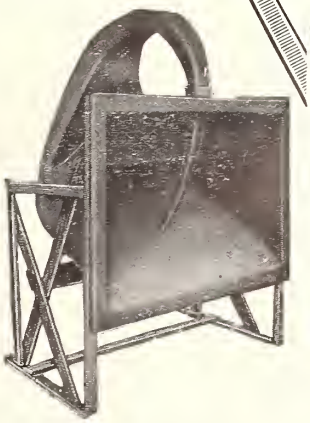

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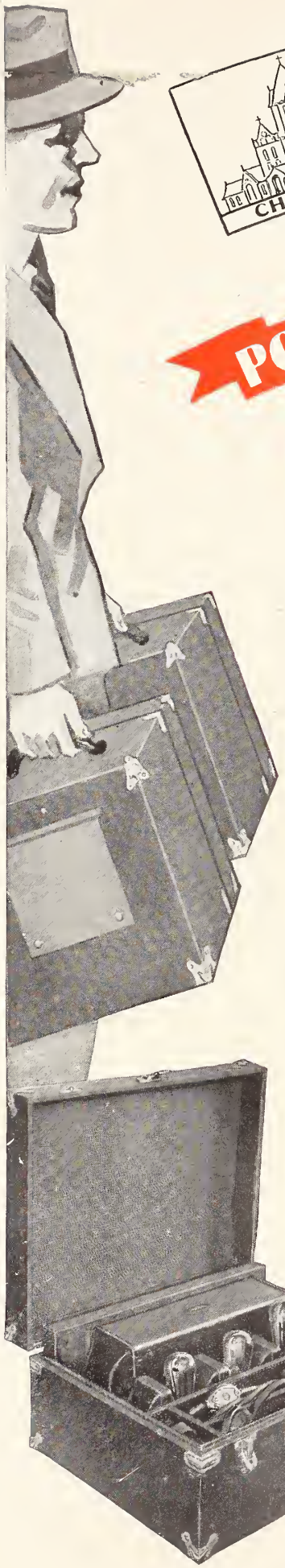

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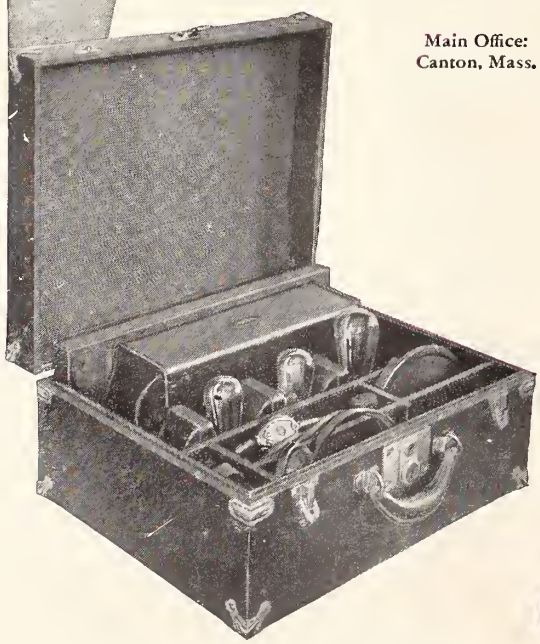

JUNE, 1931

PROJECTION ENGINEERING

SOUND · VISUAL

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Showing Loudspeaker Horns of Public-Address System, Polo Grounds Baseball Park, New York.

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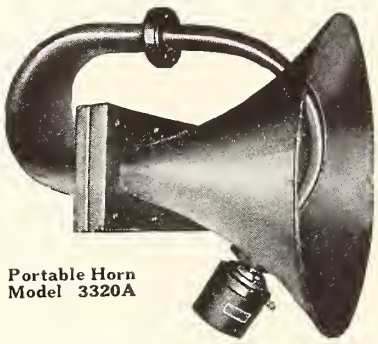

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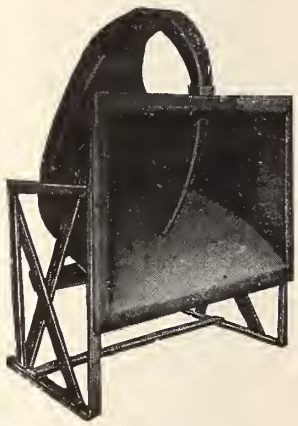

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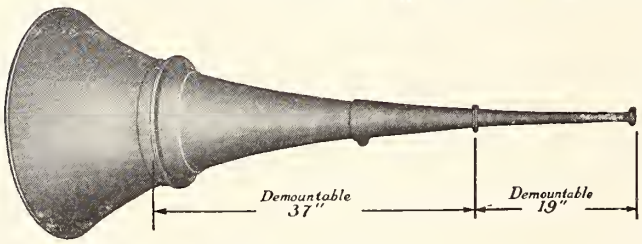

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Editorial

JUNE, 1931

THE ART OF RECORDING

IN ANY discussion of features of sound effects recording, no one else, in our opinion, knows more clearly what it is all about than does Carl Dreher.

In Mr. Dreher's paper, "Recording, Re-recording and Editing Sound Film," presented at the S. M. P. E. convention, at Hollywood, in May, there is evidence of an artistic conception of the requirements, not common among engineers. In this paper Mr. Dreher describes how re-recording and editing must be coordinated in order to yield the desired emotional and artistic effects in the finished picture.

It is a test of good picturization when the theatre patron of a critical bent, in absorption of the story screened, is lulled away from analysis of the mechanics involved.

As the illusions of projected sound and picture approach perfection this condition is realized. It is this achievement that marks the best we have in the way of coordination such as dealt with in Mr. Dreher's paper.

▲

FIRE PROTECTION

THE projection booth fire which occurred recently in the Palace Theatre, St. Louis, resulted in the death of a projectionist. The projectionist, William Gibson, was the hero of the fire. Gibson alone fought the fire to extinction but in doing so his clothes caught fire.

The first responsibility of all theatre managements is to make sure that every possible provision is made in their booths and other parts of the theatre to instantly combat fire regardless of its origin or cause.

▲

THE SPOKEN WORD

THE power for good or ill, of the written word was realized as early as Omar's day, and earlier. It was of the written word that Omar wrote: "Nor all your piety nor wit will lure it back to cancel half a line, nor all your tears wash out a word of it." And so, as far back as records may be traced the written, intelligible word, the symbol and the mark, bridge the present with the past.

The widespread applications of sound recording now being made promise to revolutionize ideas of passing along for present and future purposes those impressions of evidential value heretofore carried only by the written word.

The substance of history and the windrowed stepping stones of civilization have existence only in memory and in the written word. Blessed as have been the glory and the uses of written words, to understand their message in a large, cultural sense, has called for the establishment and maintenance of vast educational systems.

When one listens to a child haltingly reading the lines of Hamlet's soliloquy, and recalls the same words recited by a mature, experienced actor, there is food for thought in the realization that words in written or printed form only are but a part, a share of what is intended—a deficiency must be made up.

By means of sight, through reading, we may visualize events of the past. By means of sound recordings oncoming generations of men will not for the truth be entirely dependent upon the viewpoints and interpretations of scriveners and "historians."

In this matter we are on the eve of far reaching advances.

▲

AUDITORIUM ACOUSTICS

AN APPARATUS is now available by means of which it is practicable to study the acoustical properties of auditoriums—the rate of decay of sound energy in a room may be measured.

When the sound has reached the steady state the loudspeaker circuit is opened and at the same time a timer is started. When the sound energy has decayed to some definite value the timer is automatically stopped.

The subject of this measuring device is covered in a paper presented at the Hollywood convention, May 27, of the Society of Motion Picture Engineers, prepared by Messrs. V. L. Chrisler and W. F. Snyder.

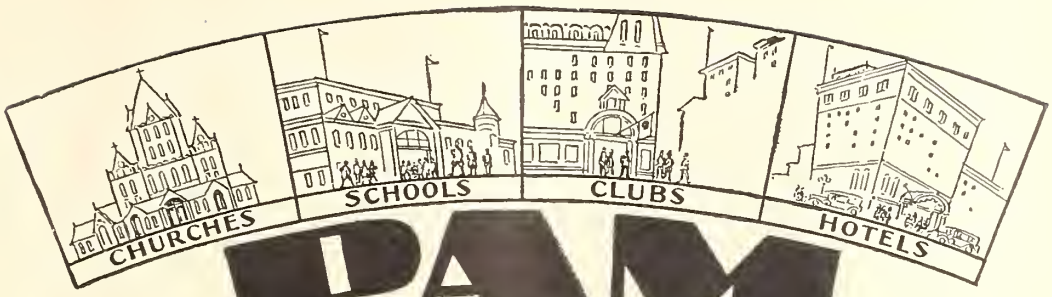
▲

PUBLIC-ADDRESS

AS PROJECTION ENGINEERING has predicted repeatedly during the past two years, the extension of sound amplifying and public-address systems is reaching commercial proportions. If all of the present business were being handled by one or two companies, there would be that many manufacturing plants operating to capacity. The fact is that the many parts which go into the makeup of public-address are being made by a score or more manufacturers. In time it may be that all of these companies will have satisfactory billings.

Donald McNicol

Editor.



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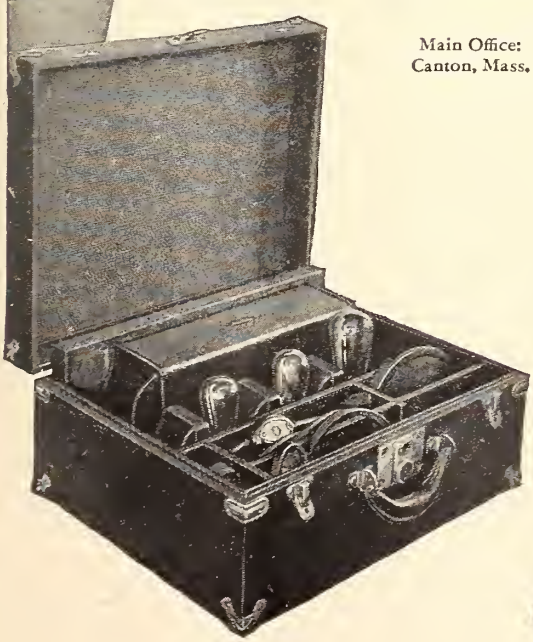

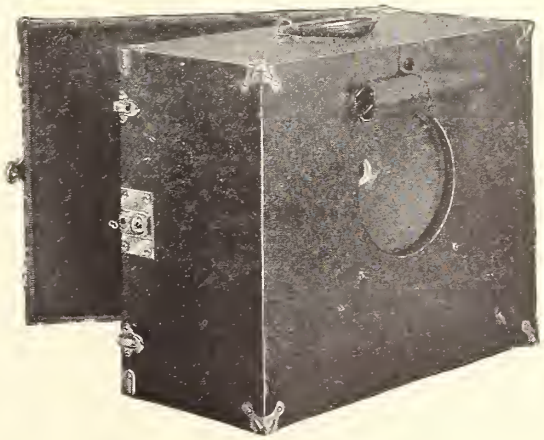

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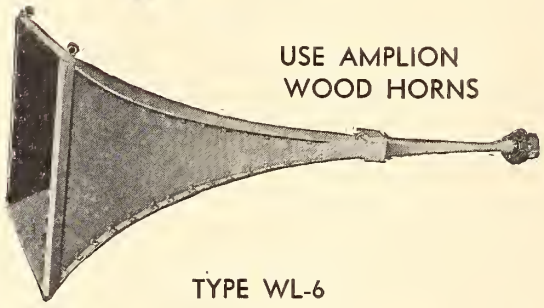

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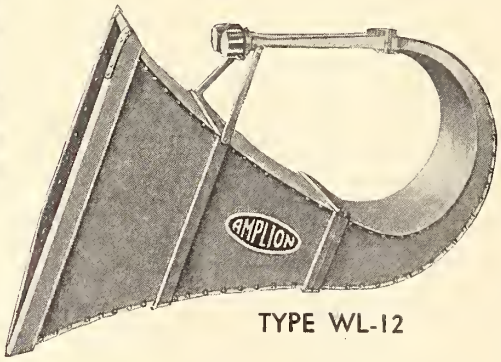

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AT FLYING FIELDS, above the noise of motors and expectant passengers, flying schedules, aviation news and last minute words of instruction are instantaneously announced through the powerful trumpet horns.

IN SCHOOLS AND CHURCHES Amplion's public address system has had widespread acceptance. For amusement and educational diversions phonograph records may be played on the electric turntable.

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Ask about Amplion's two new amplifiers—PA-50 watt amplifier for large theatres and outdoor usage, and the MP-45 combined microphone and power amplifier for small public address systems and recording.

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AMPLION

Amplion Products Corporation

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Projection Engineering

JUNE, 1931

Notes on public-address installation and operation†

By Gordon S. Mitchell*

ONE of the rapidly increasing uses to which sound amplification equipment is being put is in increasing the volume level of sound as it emanates from a relatively weak source to such a point that it may be heard throughout any size space. The public-address field is one which embraces the allied radio broadcast, sound motion picture recording and sound projection in the theatre, and developments in any one of these fields may well be applied to the public-address. Interrelated as these several industries are, their dependence upon developments in sound amplification for progress mainly means that improvements in one field will advance the entire industry step for step.

In a consideration of the development of the public-address field, some thought may well be given to the first commercial installation of the kind, which was made in the Arlington Cemetery for the burial of the Unknown Soldier in 1921. This was one of the first large installations made, and in addition to the amplification of sound in the adjacent region, embraced a transcontinental transmission of the ceremony by long distance telephone lines. Throughout, it was a problem in acoustics which was faced by the engineers responsible for the success or failure of the project.

The very nature of the ceremony and the place wherein it was held offered many problems from an acoustic standpoint. The main amphitheatre, surrounded by its colonades of marble, was the scene of the principal address. A large marble arch topped the speakers platform. The floor of the audience chambers was of concrete, lined with long benches of marble. In the midst of all this hard surface, the bodies of the listeners and their clothing offered the only sound absorptive inside of the amphitheatre.

Such universal interest having been manifest in the ceremony beforehand, the authorities in charge decided that the installation of sound amplification equipment was a necessity. Consequently, large projectors were placed in four groups, one group facing in each direction from the tops of the colonades about the amphitheatre, which would serve to increase the sound intensity to such a degree that it would be possible for vast crowds outside the arena to hear the ceremony. These projectors are numbered from one to twenty in Fig. 1. The horns were carefully directed, and provided with sufficient power to project the sound so as to be intelligible at a distance of one thousand feet from the amphitheatre.

Practical problems encountered in designing and operating sound projecting equipment.

The first tryout of the equipment showed that the sound from the group of projectors mounted over the west colonade reached the rear seats inside the amphitheatre before the sound coming from the speaker's stand direct had time to reach the same place. The time lag between these two identical sounds was of such magnitude that it was objectionably noticeable. After some experimentation, it was found that four smaller projectors, mounted directly over the speaker's stand and pointed towards the rear portion of the audience space would overcome the sound leaking in from the larger horns and correct the difficulty. These horns, number 28, 30, 31 and 33 required just the right amount of power to acquire a volume level sufficient to overcome the leakage from the larger horns, yet not enough volume to set up reflections inside the amphitheatre. The hardness of the entire inside surfaces made this a particularly ticklish proposition.

The smaller projectors number 35 and 36 were used to overcome the leakage over the western top of the colonades as were the projectors number 27 and 34 placed over the eastern colonades for the same purpose. The projectors number 3 to 6 inclusive were found to interfere seriously with speech originating at the graveside. Consequently, another set, number 22 to 26 inclusive was placed in the position shown, and the former set switched out of the circuit and these substituted when the ceremony transferred to the graveside. In order that those inside the amphitheatre would be able to follow the ceremony at the grave without leaving their seats, the projectors number 29 and 32 were placed in the position shown to be used during that part of the services. The entire assembly of projectors was divided into small groups and connected electrically to volume control dials in order that the volume level in any one portion of the audience space could be raised or lowered without disturbing the level on the remainder of the system.

Placement of Microphones

The transmitters were placed in order to give complete coverage of the ceremony—microphone A being placed in front of the box in which sat the choir and the band; microphone B being at the speakers stand; while microphone C was at the graveside. The substitution of projector group 22-26 for group 3-6 eliminated a slight singing which was noted when microphone C was in the circuit as well as eliminating the interference previously mentioned. A fourth microphone, not shown, was used by an announcer who kept the audience in New York and San Francisco informed as to what was transpiring between actual spoken events.

The speech currents from the four transmitters were amplified by a two stage amplifier which brought them up

†*Reprinted, with permission, from forthcoming textbook prepared for National Radio Institute, Washington, D. C.*

**Engineer, Universal Sound Labs.*

to moderate volume. From this amplifier they were divided into two parts, one part of which was additionally amplified to supply the projectors of the system at Arlington, the other part going to an additional amplifier and thence to the long distance telephone circuit to supply the remote stations. The necessary switches were placed at the control station at Arlington for properly dispatching the impulses to their proper destination. Two volume indicator meters were placed here also, one of which at all times showed the amount of power going into the system locally and the other to show the amount of energy entering the telephone circuit. Changing conditions at the input end necessitated constant adjustment of both amplifier circuits. Shifting of the audience and changing of the wind contributed most of the trouble from this score.

The portion of the power which was dispatched to New York City was there again divided into two parts, one of which served to feed the projectors at Madison Square Garden, the other being sent on across the continent to San Francisco. Projector arrangements at these points were largely similar to those already discussed as installed at Arlington. In order to insure against failure of any part of the system elaborate tests were conducted previous to the ceremony. In order to further guard against failure of the system at the last moment, substitute circuits were set up and maintained in readiness throughout the period of the ceremony.

With the aid of this equipment, twenty thousand persons in San Francisco and thirty-five thousand in New York City in addition to one hundred thousand at Arlington were enabled to clearly hear the entire ceremony exactly as it transpired.

The success with which this enterprise was carried through is all the more notable when it is remembered that operating practices, as they have been standardized by the experience gained in sound recording, public-address and radio broadcast, both direct and by intercity chains, were then entirely a matter of cut and try. The successful transmission of this ceremony may well be considered the first step in the foundation of the extensive public-address field as it is today.

The public-address system as it was then consisted essentially of the same pieces of apparatus as at present, although vast improvements have been made upon individual units during the last decade. Fundamentally, it is a collection of electrical apparatus designed and assembled in such a manner that it will take in sound at a low volume level, amplify this sound and reproduce it at such a level that it will be intelligible to a great number of people. The various arrangements and differentiations between sets depend upon several factors, among which might be mentioned audience size, location of transmitting apparatus, location of projection apparatus and the general uses to which the system is to be put.

Degrees of Naturalness

Present public-address equipment is limited in the range over which it may be operated successfully. While this point is of not so great importance in the transmission of speech sounds, it is of great importance in the transmission of music. The increase in the range over which the system will operate, both by increasing the high frequencies and the low will result in increased naturalness where music is concerned, and a slight increase in intelligibility where speech sounds are concerned. However, public address systems as they have been developed and improved in the last few years are entirely satisfactory as far as intelligibility characteristics are concerned. As amplifiers are improved, the frequency range over which the systems will operate will increase, for it is amplifier equipment in general which limits this factor at the present time.

Acoustic limitations of the equipment, that is, limitations on the loudness of the projected sounds which are imposed by the equipment are probably the more difficult of the two factors to improve. Experimental data has shown that the variations in loudness between two component parts of the same orchestral selection may be of a ratio as great as fifty thousand to one. Present equipment will not operate satisfactorily over such a great range in loudness level. Due to this fact, it is necessary to take care of these variations by a manual adjustment of the amplifier during the actual rendition of the selection. If the gain be varied by small enough intervals the change will not be noticeable. An increase in the loudness range—that is, an increase in the range over which the system will faithfully reproduce sound without adjustment—would make the reproduction an exact and faithful duplicate of the sound as originally produced.

Frequency Range

The audio spectrum, complete, embraces a frequency range from sixteen to about twenty thousand double vibrations per second, (d. v.). Sounds, or more properly, regular disturbances in the air strata either above or below this frequency limitation cease to be audible. Musical sounds which contain an abundance of harmonics will oftentimes reach this top frequency figure. However, an electrical system which will transmit a band of frequencies from sixteen to ten thousand d. v. per second will fulfill all requirements for satisfactory musical reproduction. A system which will transmit a band of from one hundred twenty-eight to eight thousand d. v. per second has been deemed satisfactory for speech transmission under favorable conditions, although sounds so cut off will sound somewhat unnatural to the ear. The more this range is extended at both ends the more naturalness will be given the transmitted sound.

Use to Be Made of an Installation

Arbitrary statements as to frequency requirements can never satisfactorily be made without consideration of the future use to which the system is to be put. A single example will illustrate this point. A public-address system, such as would be used by a city merchant in advertising his wares throughout the streets, (either with a portable system mounted on a truck or a permanent installation in front of his place of business) would be entirely satisfactory if it transmitted a frequency band of from one hundred to eight thousand d. v. per second. Especially would this be true were speech announcements to comprise the bulk of the program. There would be no need of an absolutely faithful reproduction of the sound embracing all frequencies, because the audience for which the program is meant would hear only a small portion of it, the audience being constantly changing and always on the move. In addition, the person hearing such a program, as he moves down the

GOOD THINGS COMING IN JULY

POLICE inquiries, examinations and investigations heretofore have been recorded by means of statements copied stenographically and typewritten. The recent development of sound systems and records has given police departments a new and valuable means of direct voice recording. This is now being used to advantage in police work. In the July issue of PROJECTION ENGINEERING will appear an account of the application of sound recording as employed by the New York Police Department.

In the July issue will be published also an exclusive story describing the Selsyn system of lighting effects as used in up to date theatres—also directly useful articles on various topics of theatre projection and public address installations.

street would hear it with only a part of his attention fixed on what he was hearing. Thinking of a myriad of extraneous things as he would be, he would only half consciously hear the selection or accompanying announcements. An exactly faithful reproduction in such a case would be wasted. On the other hand, if the system is to be used by an audience giving its entire attention to the program, such as for instance a concert in a public park on a Sunday afternoon, a faithful reproduction of the entire audio spectrum would be necessary for full enjoyment of the program.

Harmonics Important

The fundamental tone, that is, the fundamental of the melody of vocal music and certain instruments can be reproduced by a system which cuts off at the above mentioned frequencies, although music so reproduced will sound unnatural. It is the harmonics which give life and color to the transmitted musical tone, hence a system which cuts off most of the harmonics would be considered unsatisfactory for successful music transmission.

The presence of foreign noise is a problem almost exclusively of the out-of-door public-address system. Foreign noises influence the ability of the listener to hear the transmitted sounds, and thus lower the general intelligibility. In addition to this, the constant effort necessary to sort out the desired from the undesired sounds tends to tire the listener. If this strain is to be inappreciable, the sound delivered by the system should be at a power level of at least ten thousand times the power level of the extraneous noise. If a correct relationship between the transmitter and projector is not maintained, there will be foreign noise introduced, the elimination of which forms one of the most troublesome problems of the operation of public address equipment. When a portion of the sound emitted by the projectors feeds back into the microphone with sufficient intensity that its reproduction is greater, or as great, as the sound originally transmitted by the projectors, and in such phase relation that it tends to aid the original sound, the system will emit a continuous note. This is known as "singing." However, the sound may not reach the microphones in such phase relation that it will aid the original, yet may be of such intensity that it will seriously distort the transmitted speech or music. Proper placement of the microphones with relation to the projectors, determined by experiment, will eliminate the difficulty. In addition, the presence of an audience, due to damping effect, helps greatly to eliminate singing in the system.

Reflection Difficulties

An interesting point in the consideration of projector placement is the problem introduced by diffraction phenomena. Certain systems, notably those operating on athletic fields encounter distortion due to reflection of sound from regularly spaced reflectors such as open board fences. The same trouble is encountered when the sound is passed through openings regularly spaced, the transmitted sound being badly distorted in certain portions of the audience.

The public acceptance of the electromechanical reproduction of sound has contributed mightily to the advance of this new art. This in turn has been made possible by the tremendous advance in vacuum tube and amplifier performance. The operation of a public-address system at the present time is mainly a matter of experimentation—plus individual and personal knowledge applied to the problem at hand—combined and applied to each installation. However, just as radio and sound recording practices have been more or less standardized with the passage of time, so will all of the problems of public-address and sound amplification be solved and standard procedures developed. Until that time, the present success of each installation lies wholly in the hands of the operators of the equipment, who are in many cases responsible for its installation and often for its design as well. Every bit of information which can be assembled and placed available for their use will hasten the final perfection of the art of sound amplification and dissemination.

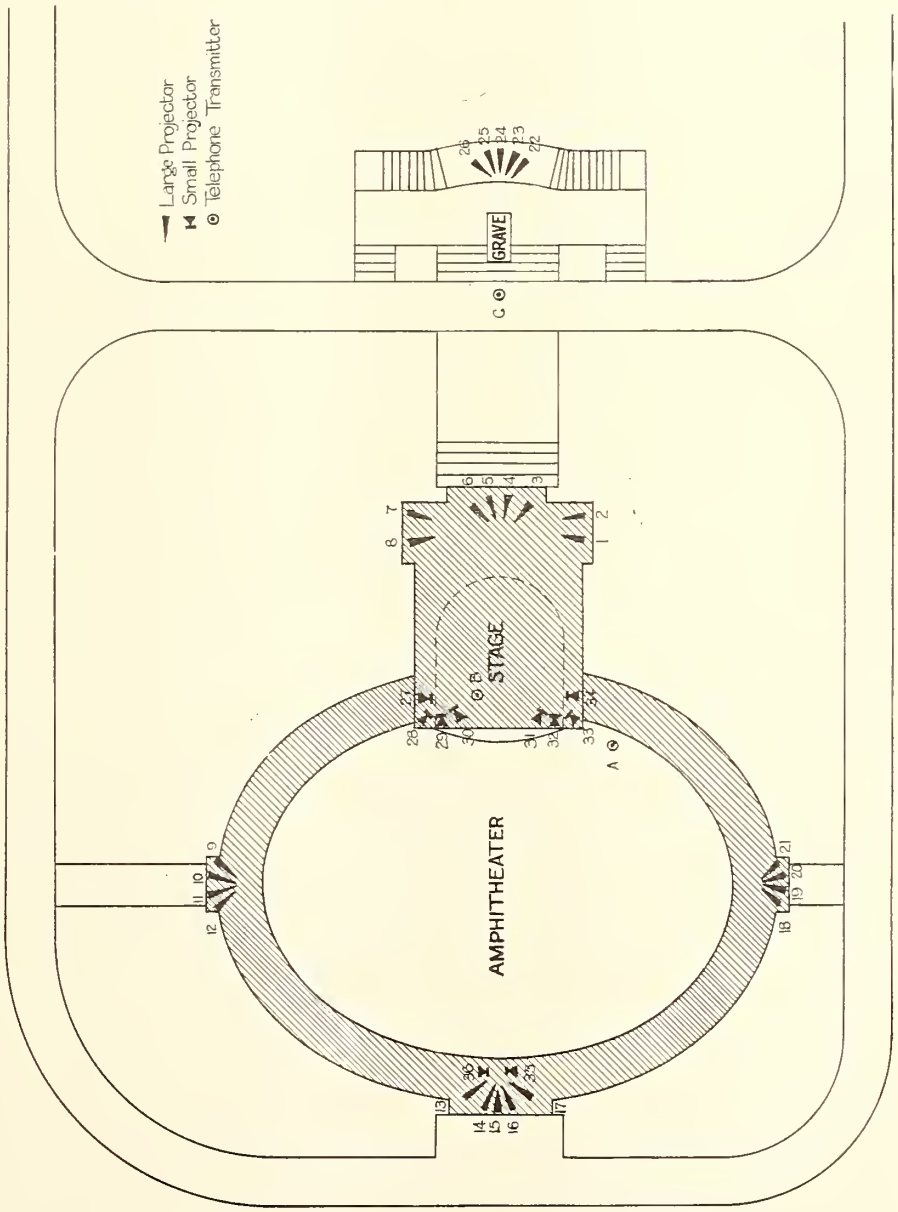

Fig. 1. Public-address system, Arlington Cemetery.

Ground Noise Reduction†

By Ralph H. Townsend
PART I
Hugh McDowell, Jr.*
PART II

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RCA Photophone System

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Part I

EVER since Thomas A. Edison made his first sound recording on a piece of tinfoil, reproduced sounds have been what we might call "victims of circumstances." This is true not only of phonograph disc reproduction but that from film as well. Always has the listener been compelled to hear reproduced sounds of speech and music accompanied by needle scratch or extraneous background noises of various sorts.

In phonography this ever present background noise was and still is a source of untoward disturbance and annoyance. It has been reduced somewhat by careful attention to the many processes involved in record production. For instance, the wax on which the original recording is made has a homogeneity and uniformity undreamed of in the early days of the art. Electrolytic copper anodes, carefully prepared solutions and accurate timing and temperature control now produce from the master record a copper plating of almost microscopic smoothness. The plastic compounds from which commercial records are pressed have been improved and refined to a remarkable degree.

But in spite of all this we still have needle scratch or surface noise to contend with.

With the advent of electrical recording the useful frequency range was greatly expanded. Electrical reproduction was capable of taking off the record all that was on it including surface noise, and then what did we do? We found by analysis and measurement that a great deal, although not all, of the disturbance from background noise lay in the frequency range above 5000 cycles. Electrical filters being easily constructed we then proceeded to cut off by means of a low pass filter everything above about 4500 cycles. The surface noise disappeared to a considerable degree but so did most of the higher frequencies we had worked so long and diligently to include in our recordings. However, the ground noise was reduced and that was what we set out to do, hence, the experiment was a success.

The use of film as a medium on which to record sounds involved all of the trouble heretofore encountered in disc recording and reproduction. As a matter of fact there is a striking similarity between the processes. Instead of granular wax we now have to contend with emulsion grain; instead of graphiting, plating and pressing we have developing and printing; instead of a plastic shellac compound we have another piece of positive film stock as a final record; instead of defective phonograph needles which do not fit the grooves we have light slits which get out of focus.

Most engineers are familiar with the reasons why ground noise interferes with reproduction and there is no necessity for a discussion of that particular point. If there were no ground noise or extraneous sound disturbances speech and music would be clearer. The question is how can the ground noise be kept out or removed without interfering in any way with the wanted sounds or frequencies.

C. R. Hanna of the Westinghouse Company and C. W. Hewlett of the General Electric Company in the early part of 1929 did considerable research on this problem and at that time devised ways and means of accomplishing such an end. So far as we know Hanna's method is the basis of all those used commercially today.

Before we go further suppose we consider for just a few moments what ground noise is. A general definition would probably run something like this. "Ground noise is all sound evident in reproduction which was not present in the original sounds." You have all sat in theatres and heard this type of disturbance but probably few have taken the trouble to try and analyze this background noise. It has been analyzed, however, and found to consist of disturbances from many different sources.

For instance during a take on a stage or set it is almost a physical impossibility to have perfect quiet. There is always a certain amount of set noise due to movement on the part of the many people who are on the set at the time, the cracking of arc lamp housings or incandescent lamp housings, noise due to the cameras and their driving motors, to say nothing of a certain amount of noise which is caused by traffic outside the studio or extraneous disturbances in adjoining studios.

The next source of noise is located in the microphones and their associated amplifiers. No matter how carefully an amplifier is constructed we always find a certain amount of noise due to circuit conditions and tube characteristics.

If we add all of the components of noise mentioned above we find that up to the film we have a total noise level which may, and often does, assume considerable proportions. In some instances actual measurements indicate that this noise level is as high as 20 db. Since all of these disturbances are included in the signal fed to the recording mechanism, whether it be an aeo light, light valve, or vibrator, all of them make their impression in the resulting sound track on the film. Every film on which recording is made has a certain definite resolving power, that is, the ability to respond evenly to exposure. The emulsion on film which is susceptible to the action of light and development is a very sensitive medium. For this reason it is very desirable that it be treated with respect.

It is not reasonable to suppose that we can subject a film to under exposure and over development or over exposure and under development and get uniformity throughout the resulting opaque portions. In other words, unless the exposure and development is carried out with precision there is the possibility that the resulting granular structure will be a source of disturbance later on.

During the developing, washing, and fixing of film there are plenty of opportunities, even in a well ordered laboratory, for the film to pick up small particles of dirt. By small I do not mean particles of a size visible to the naked eye. These particles may be, and usually are, microscopic in size. Their ability to produce noise, however, is still considerable.

The handling of film, that is, of negative film and also of the positive stock, during the printing operation is another potential source of noise. The developing and drying of the positive print is still another source.

You may well ask at this point how can the disturbance due to a recorded sound track combine with dirt and make more disturbance. If you will consider for a moment the manner in which a sound track on film is reproduced as sound the answer will be quite evident.

Most reproduction from film is accomplished by interposing the recorded

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† *Two contributions on this subject, recently presented to the Academy of Motion Picture Arts and Sciences, Hollywood.*

* *Supervising Engineer, RCA Photophone West Coast Studios, Author of Part I.*

* *RKO Radio Pictures, Author of Part II.*

film between a source of light and a photoelectric cell. The intensity and amount of light may be considered as fixed, consequently any change in the opacity or width of the sound track as it passes through the light beam will cause a variation in the current through the photocell. The output of any given cell varies directly with the amount of light change and is independent of the rate of light change. This being true it makes no difference whatever to a photocell whether the light is cut off or varied by means of a sound track variation or by specks of dirt or foreign matter on the surface of the film.

In normal variable area recording the sound track is always made up of equal portions of exposed and clear film.

Any dirt or foreign matter getting on the exposed or dark side of the track would have no effect whatever but should it get on to the clear side its presence would be noticed as noise in the reproduction. The reason for this is evident. Dirt is opaque and the dark side of the track is nearly so, but dirt on the clear portion would cause a change in the amount of light falling on the photocell and produce noise.

At normal gain settings during reproduction, the ease with which wanted sounds can be heard depends on the ratio of the recorded sounds to the ground level. In other words if the modulation during recording was low, i.e., of the order of say 10 or 15 per cent and we accumulated a little noise from each of the sources mentioned a few minutes ago we would find it difficult to distinguish speech or music above the noise level.

The problem then was how to drop the level of ground noise to a point where it no longer interfered with recorded sounds. Hanna and Hewlett did it by making opaque all that portion of the track not actually occupied by modulation.

Their method was simple and effective. They merely took a little of the output of the amplifier just before it was fed into the recording mechanism, amplified it, rectified it and used the resulting direct current to furnish what may be termed a secondary control over the vibrator.

The output from an audio frequency amplifier is in the form of alternating current. The wave shape may or may not be symmetrical but in all cases the current values during any cycle start at zero, increase to a positive maximum, decrease through zero to a negative minimum and then increase again to zero. If these values be plotted and a straight line be drawn through the zero points, this line may be considered as a base line above and below which the current values rise and fall. In RCA Photophone recording this base line corresponds to the center line of our sound track when the vibrator is at rest in its normal position.

Since the vibrator is designed to change its position with respect to this base line under the application of current changes, its position at any instant is determined by the value of the current at that same instant. As the current rises to a positive maximum, the vibrator twists to an extreme position in one direction. As the current falls through zero and decreases to a negative minimum, so the vibrator twists back through normal to an extreme position in the opposite direction.

Suppose now that some direct current were introduced into this circuit. It would have the effect of shifting the base line about which the vibrations took place to a new position and we would have a new zero line. Current changes and vibrator deflection with respect to the base line would remain the same as before but neither would be the same with respect to the new zero line.

It will be noted that the value of the d-c. from the rectifier placed across the output of the amplifier is at all times proportional to the strength of the a-c. signal so we here have an automatic and positive control over this d-c. component or "bias" if you will. In other words it is necessary only to choose, first, the new base line for the vibrator setting, and secondly, the proper value of the d-c. to return the vibrator to its heretofore normal position in the center of the sound track. Both are easily obtained and once set the ensuing action is simple, positive and automatic.

Applications of this principle have been made during the past year or more at RKO Studios and Pathé Studios, where a number of productions have been made and released.

Part II

DURING the filming of the RKO production, "Hit the Deck," in September, 1929, musical effects were desired that would produce extremes in volume beyond the range of the normal variable area recording system. At this time, Carl Dreher, director of sound at RKO Studios, mentioned to the writer a system of recording devised by C. R. Hanna, of the research laboratory of the Westinghouse Electric & Manufacturing Company, for the purpose of eliminating ground noise and consequently permitting greater volume spread. The writer was much impressed by the principle that Mr. Hanna had made use of, namely, eliminating the unused clear portion of the sound track in the variable area method of recording, and proposed further investigation. The objection was raised, however, that as this system displaced the position of the sound track at minimum modulation to the edge of the film, it was of doubtful utility in commercial projection machines, as any weave in the film in its travel might cause it to lose contact with the scanning beam during intervals of low modulation. The writer thereupon set about devising a system which would retain the advantages of Mr. Hanna's, but would keep the sound track at all times in the center of the seventy mils allotted to it on the film. The writer is also indebted to C. W. Hewlett, of the General Electric Company, for the use of a portion of his system which is similar to Mr. Hanna's.

Natural sound film recording must meet two essential requirements, namely, good quality of pickup, and range of sound from soft to loud with only a tolerable amount of noise. In standard

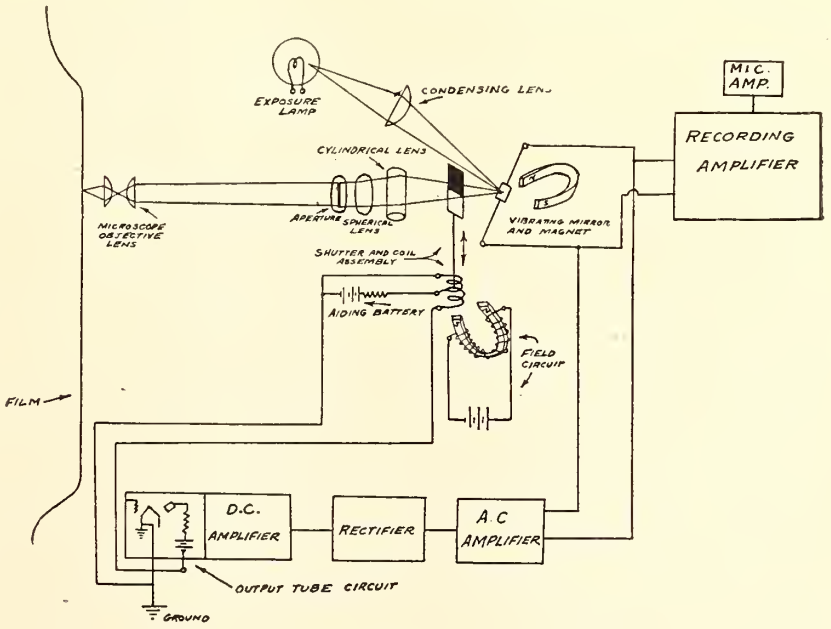

Figure 1.

methods of recording, the former is accomplished, while the latter is restricted to the limiting factor of ground noise caused by the unused clear portion of the emulsion on the film, admitting unnecessary light to the photoelectric cell of the reproducing equipment. As the light reaching the photocell is in effect the carrier of all current within the cell, it is evident that unused clear portions of the film cause the cell to produce energy not required by the legitimate sound, thereby producing extraneous noise in the output. Noise is also produced by the transparent portion of the film not being totally clear, but containing dirt, scratches, etc., which disturb the carrier in such manner as to cause additional noise, in effect, reproducing the dirt, scratches, etc. It is obvious, therefore, that in the standard method of recording sound volume reaching the film must at all times be adequate to overcome the ground noise factor, which remains constant. This requirement restricts the compass of electrically reproduced music and is an obstacle to natural and effective reproduction.

The remedy for this condition in variable area recording is found in eliminating the clear portion of the film, except at times when the modulation requires it. With this accomplished, it is possible to allow the modulation to fall to its natural minimum and rise to its natural maximum, for, with the clear portion of the film eliminated, ground noise no longer remains a constant quantity, but changes in proportion to the degree of volume.

Roughly, in standard methods of recording, the volume range from minimum to maximum is approximately 20 db., while with the anti-ground noise methods of recording described herein, the volume range may be extended to approximately 35 db.

Electrical and Mechanical Design

The following is a description of the device illustrated in Fig. 1:

Connected to the output of the recording amplifier is a two-stage amplifier of sufficient power to operate a rectifier tube following. The d-c. output from the rectifier is then passed on to a direct-current amplifier which amplifies the d-c. impulses of the rectifier, increasing their amplitude to any desired point, by varying the input voltage on the two-stage amplifier. The d-c. impulses are then fed through one-half of a voice coil of an electro-dynamic shutter movement to a resistance and battery of low voltage which aids the flow of current from the plate circuit of the d-c. amplifier to ground. Across the aiding battery and ground is connected the remaining one-half of the voice coil which is excited by the aiding battery when the normal plate current is depressed, due to rectified modulation.

It is seen, therefore, that two voice coils in series in this manner are excited in such a way as to cause one coil to exert pressure, when excited, in one direction, while the other coil exerts an opposite pressure when excited in the other direction. This balanced circuit of voice coils in the magnetic field causes pressure to be exerted equally and oppositely in both directions, and in opposite phase. To these voice coils is directly attached a moving shutter actuated by the voice coils which is placed mechanically in the beam of light reflected by the vibrating element of the recording system. The shutter, therefore, moves in proportion to the amount of input to the two-stage amplifier, moving outward under pressure of the rectifier and voice coil to accommodate the peaks of the modulation on the film, and moving backward when the modulation decreases, also under pressure of the voice coil. It is obvious, then, that electromagnetic pressure is exerted in both directions in the functioning of the shutter.

The electromagnetic assembly is supported mechanically by a lathe carriage arrangement so that manual adjustments may be made to place the shutter in the proper position with respect to the light beam.

The vibration of the shutter is in exact accordance with the d-c. impulses of the rectifier, and, therefore, it admits light to the extent required by the peak modulation reaching the film at any given instant. When no modulation occurs, the shutter is adjusted to admit to the film light approximately five thousandths in width as against thirty-five thousandths width for the normal variable area recording system. It is seen by this that there remains about ten per cent of the clear portion of the film that formerly existed. This factor in turn admits only about ten per cent of the light formerly reaching the photoelectric cell in the projector, cutting down overall excitation of the photocell when no sound is in evidence, and consequently reducing extraneous disturbances in the cell.

The equipment used in recording during 1930 consisted of a two-stage amplifier-rectifier and direct current amplifier built in a steel box 18x18x8, internally divided, the partition separating the d-c. amplifier, from the other units. The two-stage amplifier is operated from a small B-supply working from 50-cycle alternating current and supplying 250 volts to these stages. The direct current amplifier consisted of seven UX-250 tubes in parallel, fed by a 180-volt storage battery. A small meter control box containing two 0-to-500 milliammeters is used with a switch for breaking plate current and aiding battery current to the voice coils. Each voice coil has connected in series with it a milliammeter indicating the variations of current in each circuit. A variable resistance is also used in series with the battery to adjust its value so as to make the voice coils balance electrically, that is to say, when one is at maximum current, the other is at zero, and vice versa. These meters, therefore, represent the movement of the shutter.

Work on the system described was first started in November, 1929. Practical results were obtained in February, 1930, and the device put into production on Radio Pictures' "Dixiana," in March, 1930. "Dixiana" was released in August, 1930. After further development, the system was again used on Radio Pictures' production "Half Shot at Sunrise," released in September, 1930. Since this time, development has continued with the aim of simplifying and reducing the amount of apparatus necessary and to procure simpler adjustments in operation. The device will continue in use on forthcoming RKO productions.

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HIGH SPEED PANCHROMATIC NEGATIVE FILM

THE Technicians Branch of the Academy of Motion Picture Arts and Sciences met on the evening of March 31, for a symposium on the new high-speed panchromatic negative film stocks recently brought out by the Eastman and Dupont companies. The discussion centered around the practical use of the new films as compared to the old types, without comparison of the relative merits of Eastman and Dupont stocks. Leading cinematographers, film experts, laboratory technicians and electrical experts took part in the discussion. H. Keith Weeks, executive manager of Fox Studios, presided.

Emery Huse of Eastman, and J. Wesley Smith for Dupont, described the new stocks and showed demonstration reels. J. M. Nickolaus, head of the Metro - Goldwyn - Mayer laboratory, summarized the effects of the negatives on laboratory practice. L. E. Clark of Pathé Studios talked on changes in lighting equipment and practice being brought about by the high-speed film. Demonstration film, with talks, were shown by Virgil Miller, Karl Struss, Ray June, and a number of other leading cinematographers who have had experience with the new stocks.

The meeting was arranged by the Papers and Programs Committee, of which Carl Dreher is chairman. Only Academy members, and a few others by special invitation, attended the session.

"Moving talkie" brings dead language to life

Fig. 2. This "moving talkie" shows the "high" and "low" spots of Prof. H. S. Scribner's voice as he speaks into the new device developed by W. O. Osbon of the Westinghouse Research Laboratories.

A DEAD language came to life recently in a lighted room before the Greek class at the University of Pittsburgh when Prof. H. S. Scribner, head of the Greek department, spoke the famous Greek word "Eureka" into a new device developed in the Westinghouse Research Laboratories.

As the word Eureka entered the device, curious lines very much like an animated movie wriggled from left to right across a screen about the size of a large plate.

These lines showed the "high" and "low" spots of the professor's voice. They made it possible for observers to distinguish the pure from the compound notes or tones which are heard by the human ear.

Words of other languages—including French, German, Spanish, and English—were spoken into the device, and other curious lines wriggled across the screen. For the first time a moving talkie of a human voice was shown in a lighted room before a large number of persons. This device makes "moving talkies" of all sounds, as well as those of the human voice. When a stone is dropped in a pond, this device enables one to see the sound waves which the splash creates just as the eye sees the water waves. It enables engineers to examine the high and low levels of various sounds, and thus, take their first major step in relieving the tremendous strain which city noises are said to impose upon the human nervous system.

It is entirely possible to dovetail the high and low spots of many noises to produce, or approach, silence. For instance, two tuning forks with equal wavelengths or frequencies are set in motion. While each produces a note which is heard by the human ear, yet both together, under certain conditions, produce a "silent" note which is not heard by the human ear.

For specific machines, such as airplanes, the solution to our present noise problem may be in the direction of dovetailing the high and low spots of the various objectionable noises so that they do not fall within the range of the human ear.

Professor Scribner is using this apparatus for test purposes at the University of Pittsburgh.

The application of this device in schools and colleges, is not limited to reviving and showing students the correct pronunciation of dead languages such as Greek, Latin, or Sanskrit.

Language Instruction

It is expected to be helpful in teaching the correct pronunciation of English, French, Spanish, and Italian. With a photograph of a correctly pronounced word before him, the beginner is able to see just how far and in what way his pronunciation is wrong. Students should be able to learn to speak a language in nearly half the time if they can see their mistakes and correct them accordingly.

The apparatus consists essentially of an ordinary microphone such as is used in radio broadcasting, the new cathode ray oscilloscope and some batteries. The whole setup can be packed in two large suitcases.

The heart of this new instrument is the cathode ray tube of the oscilloscope. It resembles a funnel about the size of an old fashioned phonograph horn-speaker. The large end of the tube, about the size of a dinner plate, fills a round opening on the front panel of the case. This is the screen upon which the moving talkies strut their stuff.

In the neck of the funnel is an "electron gun" that shoots a narrow beam of electrons toward the large end, or screen. These electrons strike the inside surface with a very high velocity due to the influence of high voltage impressed on a coating of silver on the inside surface of the tapered part of the tube. The bombardment of any small spot on the inside surface by a narrow high speed beam of electrons causes the spot to glow on the outside with a bright green light.

The bright spot is caused to move about on the screen by deflecting the beam of electrons as it emerges from

(Concluded on page 22)

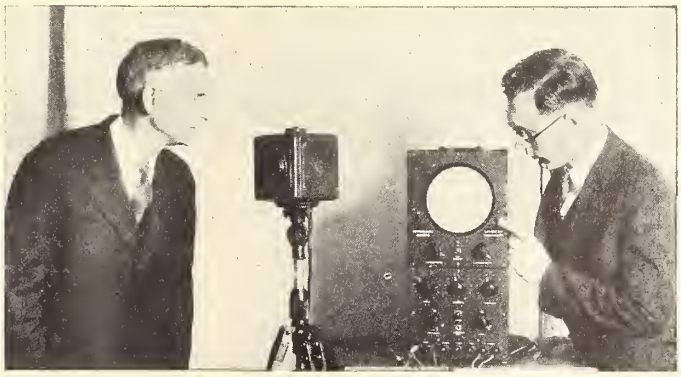

Fig. 1. A dead language comes to life as Prof. H. S. Scribner speaks the famous Greek word "Eureka" into a new device developed by W. O. Osbon of the Westinghouse Research Laboratories.
Mr. Osbon is pointing to the curious wriggling lines which are "moving talkies" of the word "Eureka."

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New method of studying the shape of any a-c. voltage or current.

Film recording in sound motion pictures

Part II

By Charles Felstead*

Detailed description of procedure in making sound records on film, including Fox Movietone and Western Electric

IN the first article on film recording (May, 1931, issue) the general methods of recording sound on motion picture film were considered, and the construction of a film recording machine of the type employed in the Western Electric system of sound recording, together with its associated apparatus, was studied in detail. The discussion is taken up in this second article at the point where it was left off in the previous article, and we begin with an examination of the mechanical construction of the light valve, which is the light modulating device used in the Western Electric recording system.

The frame of the light valve is formed of a flat slab of metal that just fits across the two side arms of the E-shaped core of the electromagnet. Two screws with knurled knobs hold it firmly and exactly in position when it is placed on the core. This flat piece of metal forms the armature of the electromagnet, and it is equipped with a central projecting wedge of metal that is just like the wedge-shaped end of the center leg of the electromagnet. Likewise, there is a similar slot cut in this elevation of metal on the center of the armature. On the front face of the wedge, the opening is eight mils wide by 256 mils long and it tapers out to an opening 204 mils wide by 256 mils long in the outside face of the armature, which is exactly like the tapered slot in the electromagnet core. When the light valve is fastened in place on the core, the wedge-shaped elevation in the center of the frame of the light valve is precisely opposite the similar wedge-shaped end of the center leg of the core, and the small ends of both slots are parallel and facing each other. With the light valve thus in position, the two elevations are spaced eight mils apart when there is no current flowing through the winding on the electromagnet, but when the electromagnet is energized from the battery, this air gap is reduced to seven mils.

Ribbon Support

On the face of the light valve frame, which is the side that has the central elevation, there are two screw-like arrangements called windlasses mounted near one end. These windlasses are slotted to hold the two ends of a loop of duralumin ribbon, and they fit their mountings tightly enough so that they will not turn of their own accord and permit the ends of the ribbon to come loose. One windlass is insulated from the light valve frame, but the other one is grounded directly to the frame, and they connect to the two binding posts on the back of the frame that form the two terminals of the valve. The center of the loop of ribbon is drawn tight by a miniature, spring-held pulley mounted at the other end of the light valve frame. This pulley is insulated, and it is constructed so that the spring keeps a constant tension on the loop of ribbon. The strength of the pull of the spring on the ribbon can be regulated by means of a screw that projects through to the back of the metal frame. Insulating bridges are mounted on each side of the central elevation, and the windlasses and the pulley are arranged so that the two sides of the loop of ribbon are supported by the bridges just three mils above the face of the projecting metal wedge in the center of the frame. These bridges are comparable to the bridge that holds the strings of a violin, only in this case the bridges are smooth and not slotted.

Four adjustable insulated pincers confine the two sides of the loop of ribbon to the centers of the insulating bridges, which places the two sides of the loop directly over the longitudinal dimension of the tapered slot in the face of the projecting wedge. When the two ribbons are properly centered over the slot and spaced exactly one mil apart by adjusting the four pincers, they shut off most of the opening, and if the light valve is viewed against a light the slot appears to be only one mil wide and 256 mils long. The flat side of the portion of the ribbon that passes over the slot is parallel with the face of the light valve frame, but the rest of the ribbon is turned so that the flat side of the ribbon is perpendicular to the frame. When the light valve is mounted on the electromagnet core, the ribbon is approximately centered in the air gap between the wedge-shaped elevations on the core and on the light valve frame; and, as has been explained, the sides of the ribbon loop contract the size of the aperture through which the light from the lamp can pass to a width of just one mil.

Size of Image

The objective lens in the end of the exposure chamber has a two-to-one ratio, and so it reduces the optical image of the slit at the point where it is focused on the film to one-half the actual slit dimensions. This means that the image on the film is one-half mil wide and 128 mils long when the light valve strings are in their normal position of rest. In printing the film after it has been developed, a part of the sound track is matted off in the printer, however, leaving a track just 100 mills wide on the final positive print that is released to theatres.

Stringing the light valve, which is the term used for the operation of placing the loop of ribbon on the valve frame and adjusting it over the slot, is a very delicate operation that requires extreme care on the part of the recording operator. The duralumin ribbon is purchased in strips of the right length fastened to a sheet of metal. The ribbon must be handled very gently with tweezers, because any kinks or twists in it will make it unsuitable for use. It is placed carefully in position on the light valve frame with the center of the loop over the insulated pulley and the two ends put through the slots in the windlasses. The windlasses are turned slowly then by means of screwdrivers. This serves to twist the ends of the ribbon around the windlasses and secure it in place, and also to draw the loop of ribbon tight. After the ribbon has been pulled up firmly into position, the light valve is placed in a special frame under the lens of a microscope and the four pincers adjusted until the

* *Sound Engineer, Universal Pictures Corporation.*

two sides of the ribbon loop are exactly centered over the slot in the projecting wedge on the frame and are spaced precisely one mil apart over the entire length of the slot.

Tuning the Light Valve

After stringing, the light valve is tuned by means of a light valve tuning panel. This tuning panel comprises an adjustable audio-frequency oscillator that supplies a tone of predetermined frequency to the light valve. The light valve is mounted on an electromagnet on the front of the tuning panel in the regular manner and a light directed through it onto the sensitive surface of a photoelectric cell. There is an amplifier that terminates in a volume indicator connected to the output of this photoelectric cell. With the light valve in place on the tuning panel, the apparatus is turned on and a tone generated by the audio oscillator is sent through the strings of the valve. The frequency of the tone is adjusted to the valve to which it is desired to tune the natural period of vibration of the valve ribbon. A frequency of 8,500 cycles per second is usually chosen for this valve—although 7,000 c.p.s. used to be employed, because it places the resonant frequency of the light valve strings well out of the frequency band that the human voice occupies. With the oscillator in the tuning panel generating a frequency of this valve, the tension on the loop of ribbon in the light valve is slowly increased by turning the screw attached to the spring that holds the pulley in the center of the ribbon loop. When the tension on the ribbon is great enough to cause the resonant frequency of the valve ribbons to reach a value that is the same as that generated by the audio oscillator, the amplitude of vibration of the strings will attain a maximum value and the meter of the volume indicator will indicate highest reading at this point.

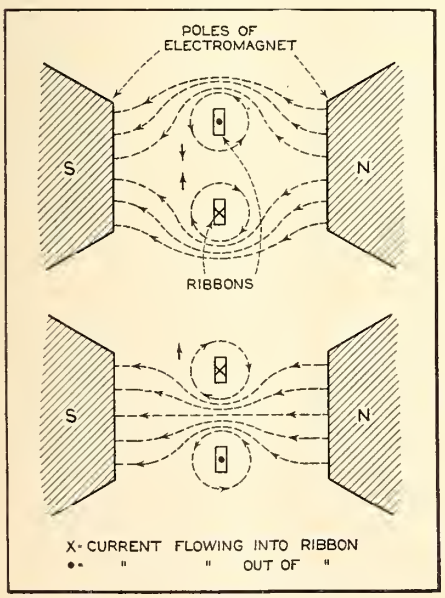


Fig. 2a. (at top). Current flow on one-half cycle causes reaction of fields to draw ribbons toward each other. Fig. 2b. (below). Current flow on other half of cycle causes reaction of fields to force ribbons away from each other.

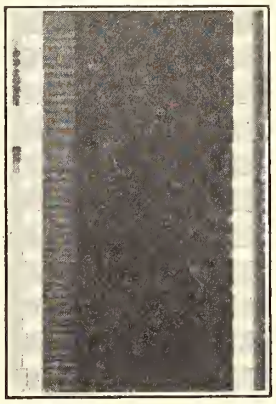
The Tuning Panel

Besides the volume indicator meter and the potentiometer that permits the grid bias on the volume indicator tube to be adjusted to the valve that gives a five-division reading on the meter scale when there is no a-c. excitation, there are a number of other meters and controls mounted on the light valve tuning panel. There are rheostats and ammeters in series with the oscillator tube filaments, the amplifier tube filaments, and the sound lamp that provides the light of constant intensity that acts through the light valve on the sensitive surface of the photoelectric cell. Then there are the switches that turn on and off the battery circuits and the input to the light valve, and a potentiometer that controls the a-c. tone input to the light valve strings. The dial of the frequency control is marked directly in frequencies, and there is a three-position key switch just below it that provides the three frequency ranges which carry the range of the oscillator well above and below the 8,500-cycle tuning point of the light valve.

After it has been tuned, it is necessary to examine the ribbons of the light valve under the microscope again to determine if there has been any variation throughout the length of the slot in the one mil spacing of the ribbons. If there has been any divergence from this value, it will be necessary to readjust the spacing of the ribbons by means of the pincers. The light valve must be examined under the microscope also to make sure that there are no nicks or imperfections in the edges of the ribbons where they form the sides of the slit and that there are no bits of fuzz or particles of dirt in the slot, for any of those things would cause streaks in the sound track produced by that valve. Specks of dust and dirt can be removed by a fine camel's hair brush. The only thing that can be done for a valve with nicked or imperfect ribbon is to break and re-string it with new ribbon. The slot in the core of the electromagnet should likewise be examined for particles of dirt by placing a small light inside of the exposure chamber and observing it through the slot by means of a powerful magnifying glass. All of the operations described in this paragraph have to be carried out each time a light valve is to be put in service on a recording machine. When a poor grade of ribbon is encountered, it is sometimes necessary to re-string and re-tune a light valve a half dozen times before it is satisfactory.

Principle of Light Valve

The principle on which the light valve operates is the same principle as that which causes an electrodynamic loudspeaker to function, but in the light valve the duralumin ribbon takes the place of the speech coil and the diaphragm of the dynamic speaker. The speech current from the recording amplifiers is fed to the loop of ribbon in the light valve through a repeat coil that matches the impedance of the amplifier output to the impedance of the strings in the light valve. With the light valve in position on the electromagnet core the ribbons are suspended in a plane at right angles to the electromagnetic field of force produced by the d-c. current flowing through the winding of the electromagnet. When sound is not being picked up by the microphones there is no speech current flowing through the loop of ribbon on the light valve, and so the ribbon has no field of force of its own. When such is the case the flux produced by the electromagnet has absolutely no effect on the ribbons because they are of non-magnetic material. But when an a-c. speech current flows through the loop of ribbon an alternating field of force is set up around the ribbon. On one half of the a-c. cycle the field around the ribbons reacts with the field of the electromagnet in such a way that it tends to cause the two ribbons to be brought together, and on the other half of the a-c. cycle the two fluxes react to cause the two ribbons to be forced apart. This action can be made evident by applying the law of electromagnetic induction to a study of the reaction of the fields produced by the current flowing in the electromagnet winding and in the loop of ribbon; as is illustrated in Fig. 2.



Section of film showing sound track, variable density, fixed area type.

The tendency of the lines of force flowing between the two poles of the electromagnet is to assume straight paths from one pole to the other. Faraday thought of these lines of force as acting like stretched rubber bands: that is, they can be bent out of their natural positions, but when the force that is holding them is released they will

snap back into position again. A modification of Lenz's law states that *a wire carrying a current in a magnetic field tends to move in a direction at right angles both to the direction of the field and to the direction of the current.* This is sometimes known as the *motor rule,* because it is this principle that causes electric motors to function. In Fig. 2a, the reaction of the fields of the ribbons and of the electromagnet causes most of the lines of force from the electromagnet to be bent around the outsides of the two ribbons. Now, in this case, the strength of the field on the outsides of the ribbons is the sum of the two separate fields, while the strength of the field between the ribbons is the difference of the two fields. If we think of the lines of force acting like stretched rubber bands, as did Faraday, then we will see that the energy exerted by these lines of force in an effort to take straight paths between the poles of the electromagnet will tend to bring the two ribbons closer together. In Fig. 2b, which represents the current flow on the other half of the a-c. cycle, exactly the opposite action takes place and the ribbons are forced farther apart by the reacting magnetic fields. In these illustrations, a cross-section of the ribbons is shown; and the *X* indicates the current flowing *into* the page, while the dot represents the current flowing *out* of the page.

Vibration of Ribbon

So we see that an a-c. speech current passing through the ribbon loop causes the two sides of the loop to be alternately drawn toward each other and forced apart by the reacting magnetic fields. In an ideal recording system, this movement of the ribbons is of the same frequency as the frequency of the a-c. speech current, which in turn has the same frequency as the sounds producing it; and the amplitude of the movement of the ribbons corresponds precisely to the amplitude of the speech current. This narrowing and widening of the light slit by the ribbons alternately reduces and increases the amount of light from the lamp that falls on the moving film. This results in narrow and wide bands, or striations, of varying density running transversely of the sound track on the film, as may be seen in the photograph (Fig. 3) of a strip of sound track of the variable density-fixed area type. This sound track is of the full 128-mil width. The higher the pitch of the sound producing the modulation of the light beam, the narrower and the closer together will be the lines of the sound track; and, the louder the sound, the greater will be the contrast in density between adjacent light and dark lines on the film.

Operation of Recorder

The operation of a film recording machine during the actual making of a sound motion picture requires considerable experience and close attention to detail on the part of the recorder operator. The various departments in the sound studio—stage, monitoring, amplifying, and recording—are connected by a system of colored signal lights and intercommunicating telephones. The recorder operator loads his recording machine with a 1000-foot roll of film; punches the start mark in it; numbers it properly; sets the footage counters on the recording machine at zero, and then writes down all the details, such as picture number, director, film roll number, and film recorder number on a special form card. He turns on the current to the various recording circuits and adjusts the rheostats to the positions that provide the proper meter readings. When the director and cast on the stage are ready to make a sound "take," the microphone man calls the recorder operator on the telephone, gives him the scene number and calls for "interlock." The recording technician then throws the first of the two motor switches mounted on the wall near the recording machine and turns on the recording room signal light. This motor switch interlocks all of the motors and brings them to the starting position. The microphone man calls out, "Interlock," when he sees the recording room light go on, and when everything is quiet on the stage, he turns on his stage signal light, and warns, "We're running." At sight of the stage signal light, the recorder operator closes the second motor switch, which sets all of the interlocked motors into rotation. He adjusts the motor rheostat that compensates for changes in the amount of load on the master Selsyn motor in the generator room, and watches the extension milliammeter in the motor control circuit until it shows a reading that indicates the motors are up to their normal speed of 1200 r. p. m. Then, when the motors have reached their full speed, he turns on the bull's eye running light. At this, the microphone man calls out, "Speed," the scene is "shot," and the stage signal light is switched off. The recorder operator then turns off the motors; writes down the scene number, whether or not it was ok, and the number of feet of film run through the machine, and makes the necessary preparations for the next take.

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Future Developments in Moving Pictures

MR. LESLIE ROWSON, of London, England, returned recently to that city after an American trip which included a visit in Hollywood.

The following is that portion of Mr. Rowson's report of his observations which deals with probable future developments:

"Many improvements loom dimly ahead—wide film, natural colors, stereoscopy and television. Which one of these will come first? Twelve months ago wide film in one form or another seemed to be a certainty for the immediate future: the public, however, showed no interest in it, and it has been quietly shelved, temporarily, at any rate.

"That a new standard size of picture will eventually be adopted seems probable, but what it will be, one can hardly say. Certainly not the wide, flat shape which met with so little success last year.

"On the purely photographic side, I think we can hope for very much faster film. Eastman Kodak have recently placed on the market in America a new film, three times faster than the Type 2 Panchromatic at present in use, and I am sure that the limit in this direction has by no means been reached.

"As regards lenses, I do not think we can expect any very great advances as regards speed, as covering power and depth of focus both become very poor at apertures larger than f.2.

"Stereoscopy, I am certain, we will have within the next few years, though I do not believe there is any optical principle at present known by which it can be achieved, but I am certain that some new principle will be discovered which will startle us all by its simplicity.

"Television is knocking at the door, and the only factor which is preventing its immediate entrance is, I understand, the purely mechanical difficulty of obtaining a picture of adequate size.

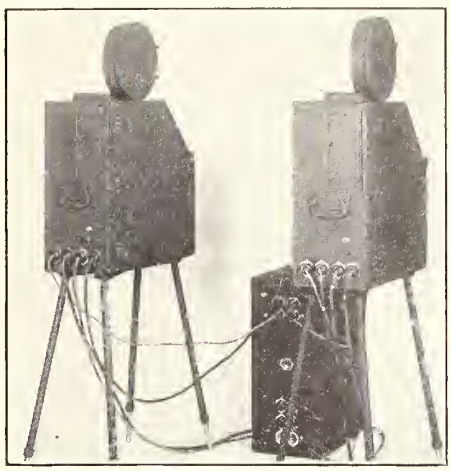
"Natural color, too, is just around the corner; Eastman Kodak, Multicolor, and other important companies are working on it, and the solution cannot be long delayed.

"Anyhow, if I may be allowed to speculate as to the future, I predict stereoscopic pictures in color projected by television from a single print to a whole chain of theatres on to a screen whose shape continually changes to suit the composition of the scene which is being projected.

"But of one thing I am certain. Whatever new forms cinematograph entertainment may take, there is one man at least who will always find himself striving to improve his knowledge and increase his mastery of his medium, and that is the cameraman."

An a-c. operated portable talking picture equipment

By J. deGiovanni



Complete equipment of portable movie-talker.

THE portable equipment described in this article was designed to meet the requirements demanded in this field of highly specialized work. Quality of reproduction, portability, ease of operation, flexibility to meet field conditions; each were factors which required serious consideration and much technical research was expended over a period of two years before the present instrument was designed.

What can be more simple than to be able to plug into an ordinary a-c. house line and in a few minutes give a talking picture show equivalent in performance to the best of theatre installations? Transportation of this unit simply resolves itself into a mere trunk carrying proposition.

On the field, the power supply is somewhat serious. Because of their weight, motor-generators are out of the question. For long performances batteries are not reliable enough and entail considerable trouble.

A system known as the G. R. C. portable has been tested and operated in the field. This portable sound picture equipment has been designed along sound engineering principles. All the requirements were carefully compiled and a unit was designed that not only meets the requirements of a portable equipment but also that of the semi-professional field. This unit can be used in small class-rooms as well as in large theatres of over 1000 seats. The only change required is the use of two or more exponential horns to meet the sound distribution requirements.

Description of the Apparatus

Not only is the projector, protected and enclosed, but another metal case completely encloses the entire unit. This metal case is lined with sheet rock asbestos. Both upper and lower magazines are totally enclosed. With this type of assembly, fire hazards are reduced to a minimum, a feature which is all important when the equipment is being used in class-rooms or other places where it is impossible to use a booth.

The projector is powered with a constant-speed motor, dynamically balanced, and the frame filtered from vibrations. All driving is done through shafts or gears, no belting or chains being used. The sound-head is driven by a separate shaft other than that used to drive the projector mechanism, thereby eliminating speed fluctuations due to mechanical overloads on the projector mechanism.

To further insure against "gargle" and uneven speed, the driving sprocket is filtered against gear noises and other vibrations that would tend to introduce ground noises. The picture can be framed while the projector is running, and without necessitating opening the doors.

Provisions are made to insure easy and free motion of the film, thereby contributing an important element towards obtaining pure and natural tone.

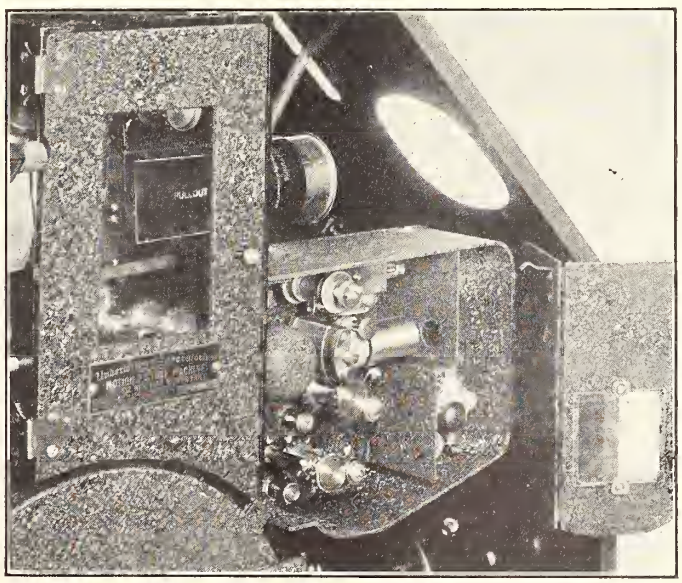
The optical system used in the sound head is designed along new lines. Its construction eliminates the "mechanical slit" and allows more freedom in the operation of the photocell. The photoelectric cell and its circuit do not require extreme amplification in order to obtain volume with high quality reproduction. The lens block has been designed so that the optical system may be taken out and cleaned without making it necessary to readjust it after it has been replaced.

The lamphouse is enclosed in a separate metal case and lined with asbestos. A blast of air is blown upwards through the lamphouse expelling the heat generated by the projection lamp. A 1000-watt projection lamp insures brilliant pictures even with throws exceeding 80 feet.

The a-c. operated amplifier and power-pack is designed to operate from a 110-volt 60-cycle a-c. No batteries are necessary. The current consumption is such that it can be plugged into an ordinary light socket without special precautions. This amplifier includes

(*Concluded on page 22*)

Projector unit.



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A Practical Talking Picture Outfit Contained in Three Medium Size Trunks

Motion picture cost accounting

TO the motion-picture corporation costs of production correspond to cost of sales, and for a true report of earnings it is necessary to adopt conservative and common-sense methods of distributing production costs over the period of earning power of a film.

Since the advent of talking pictures there has been a substantial change in the rate at which film negative costs are charged against rentals. Earnings from a picture are garnered now in a much shorter period than in the days of silent films, and there has been consequently a shortening of the period in which the entire cost of production is written off.

This process of amortization, the writing down of cost over a number of months, in its simplest form follows a schedule that is drawn up readily on the basis of experience. The corporation totals in one column the production cost of a number of films, good and bad together; in other columns it sets up, month by month, the revenues from those pictures until they reach a level approaching the vanishing point. The total earnings of each month in the life of the group is then calculated as a percentage of the total earnings received from the group, and this percentage fixes the amount of the production cost to be charged against all films of the corporation.

The table shows the actual amortization schedule used by one producer in the time of silent pictures.

Thus it appears that by the end of the sixth month the corporation had received 62 per cent. of the revenue to be expected from the film; at the end of a year, 90 per cent.; and in eighteen months, 100 per cent.

Practice among various companies differed and still does. Some companies might follow the very conservative practice of writing off the whole production cost as soon as a picture is released. The objection to this is that, although it gives the same result in the long run as a periodic writeoff, it distorts the earnings for any period in which a high cost picture is released. If a million-dollar feature were issued on December 15, for example, $1,000,000 would be knocked out of earnings in the report for the quarter or the year, without any corresponding offset in revenues from the feature.

Another variant is to charge a certain percentage from revenues to cost of production. In the case of a flop, of course, earnings would never supply enough to permit writing down the whole cost, and inventory would be padded by this undepreciated item. Setting an arbitrary date for completing the writeoff, regardless of insufficiency of revenues from the film, corrects that evil but produces the other one of throwing an unexpected and unwarranted burden of depreciation into the month in which the final charge is made.

Month After Released.	Per Cent. of Life Revenue Received	Cumulative Per Cent. Received.
1	12½	12½
2	14	26½
3	12	38½
4	9½	48
5	8	56
6	6	62
7	7	69
8	6	75
9	5	80
10	4	84
11	3½	87½
12	2½	90
13	2½	92½
14	2½	95
15	1½	96½
16	1½	98
17	1	99
18	1	100

It is almost universal practice, therefore, to follow a diminishing scale of depreciation charges that starts at a high rate and rapidly writes off the total cost.

Changes in the industry in the past five years have accelerated the rate of this depreciation.

When the large producing companies gathered up great chains of theaters as distributing outlets, the need for quick circulation of new films among the quality houses was realized. Prompt distribution of new releases also was demanded by the small theaters who had invested in equipment for sound. The result, facilitated by lower cost of film itself, was a great increase in the number of prints circulated simultaneously and a shortening of the domestic earning life of a production.

Thus it is usual now for producers to receive 65 to 70 per cent. of the probable total domestic earnings of a film during the first three months following release and 85 to 90 per cent. in the first six months.

The Fox Film Corporation audit prepared for the purposes of the recent financing established a revised amortization schedule that writes off 93½ per cent. of production cost in the first twenty-six weeks of a film's distribution, compared with previous rates reported to have allowed approximately a year.

The problem of amortization chargeable to foreign rentals has many ramifications. Probably typical practice is to allocate 15 or 20 per cent. of production cost as a charge to be written off out of the earnings of prints circulated in foreign countries. The rate of this amortization might well be slower than on domestic distribution because of the longer earning life of many American films in foreign houses, but there, as at home, the introduction of talking pictures is bringing changes.—*New York Times, April* 19, 1931.

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Practices in amortizing film costs differ in motion picture industry

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LIGHT REFLECTION OF ACOUSTICAL MATERIALS

TOO often are the purchasers of acoustical materials inclined to think in terms of sound absorption coefficients only. Many other characteristics merit consideration. Light reflection is a very important factor. This is emphasized in a recent article by A. L. Powell and C. L. Dows of the Nela Park engineering department of the General Electric Company published in the December, 1930, issue of the Transactions of the Illuminating Engineering Society. The article also reports tests on the light reflection of many acoustical materials.

Some time it is hoped that similar tests can be made on material over a considerable period of time. Such tests would show up another important characteristic of acoustical materials—paintability. The accumulation of dirt on the ceilings of offices is unfortunately a reality and if high light reflection is to be maintained painting at frequent intervals is essential.

Examination questions for projectionists

Herewith is presented a list of guiding questions which applicants for grade A projectionist licenses in Canada are expected to be prepared to answer correctly

THE first 182 questions appeared in the May issue of PROJECTION ENGINEERING.

183. Why must all equipment be grounded?

184. What is an overloaded circuit?

185. Why should projectors be grounded?

186. What is a test lamp?

187. How would you test fuses?

188. Explain how to find the positive wire on a d-c. line with a test lamp.

189. How would you find the positive wire on a d-c. line if you had no test lamp?

190. What is meant by the term e.m.f.?

191. What is meant by the primary side of a transformer?

192. What is meant by the secondary side of a transformer?

193. Using 25 cycle, how many alternations are there per second?

194. What is meant when voltage is "stepped up"?

195. What is the first indication of a short circuit?

196. Give types of fuses used in motion picture projection.

197. What is voltage drop, and what effect will it have on a carbon arc?

198. What advantages has d-c. over a-c. on a carbon arc?

199. How would you test for a ground in the arc lamp?

200. What will cause wires to burn off at carbon arms?

201. Where does a ground usually occur in the lamp?

202. In an electric arc circuit, what various things offer resistance to the flow of current?

203. What advantages are there to copper-coated negative carbons?

204. Name some types of arc lamps in use.

205. What determines the diameter of carbons used?

206. What is the average amperage required on mazda illumination?

207. What is meant by stealing the arc?

208. What causes the asbestos covering on lamp leads to become cracked and broken?

209. Which gives the best projection arc results on a-c.? A motor generator, transformer, rheostat, mercury arc rectifier?

210. Does the arc-gap offer any resistance?

211. Show by diagram the wiring in a circuit of a polarity reversing switch.

212. Should lamp houses be vented to the open air, and if so, why?

213. What is a reflector lamp?

214. What is a Hi-low lamp?

215. What might cause breakage of reflector and condensor while arc is lit?

216. How often should carbon jaws or clamps be cleaned?

217. How would you clean carbon jaws so as to make good electrical contact?

218. What will a coating of carbon dust or ash on the lamp insulation cause?

219. What will be the result of the carbon jaws or clamps making loose connections with the carbons?

220. What will cause pencilling of carbons? Give more than one reason.

221. Should you lubricate the carbon clamp screws, and what with?

222. What would result from one carbon making accidental contact with the lamp house walls or floor?

223. What is the positive arm of an arc lamp?

224. What is the negative arm of an arc lamp?

225. What will be the result of the silver backing of the mirror wearing out?

226. Can a cracked mirror be used?

227. What is the average amperage used with old style arc lamp?

228. What is average amperage on high intensity?

229. What is average amperage on reflector arc?

230. What is average amperage on Hi-low arc?

231. With a reflector type arc, how can the spot at the aperture be enlarged?

232. Why do high intensity arcs have the positive carbon revolve?

233. What prevents the burning away of the lamp metal due to excessive heat from the high intensity arc?

234. Is the film fire hazard in a reflector arc lamp with condensor opening free greater than with any other light source? If so, why?

235. What is the purpose of a fuse?

236. Should fuses carry more than their rated capacity?

237. What is meant by over-fusing, and is it permissible?

238. What happens when a fuse blows?

239. What causes a fuse to blow?

240. What is the construction of a rheostat?

241. What is best to use on a-c., an economizer or rheostat, and why?

242. When using 220 v. d-c., how many rheostats would you use, and how wired?

243. Show by sketch how to connect two rheostats in series.

244. Show by sketch how to connect two rheostats in multiple.

245. What is a rheostat used for?

246. What is a coil type rheostat?

247. What is a grid type rheostat?

248. When are rheostats used in series?

249. When are rheostats used in multiple?

250. How would you test a rheostat to find out which coil or grid is burned out?

251. What is meant by an adjustable rheostat?

252. What is meant by a fixed rheostat?

253. If the voltage drops, what effect will the cutting out of resistance have?

254. If the coil or grids of a rheostat become bright red, what would that indicate, and what would you do?

255. What precautions must be taken in location of rheostats, and how would you protect same?

256. Should rheostats be inspected frequently?

257. If a coil should burn out, how could you make an emergency repair?

258. Why are rheostats commonly used on a 110 v. d-c. circuit?

259. Where rheostats are used on d-c., what value is there in connecting rheostat; (a) on the positive line; (b) on the negative line?

260. Why are some starting switches on motor generators and larger equipment enclosed in oil?

261. Should m.g. sets be kept well cleaned and lubricated, and why?

262. Should all m.g. sets be grounded, and, if so, why?

263. How should the commutator be kept clean?

264. How tight should the brush tension be on the commutator?

265. What will cause a bearing to run hot?

266. When would you consider a m.g. set to be heating excessively?

267. How do you replace old brushes and fit the new ones to the curvature of the commutator?

268. Give two or more reasons why brushes on a m.g. set will spark.

269. What are the causes for brushes sparking, and what are the remedies?

270. What is a motor generator?

271. What is meant by the armature?

272. Give the chief causes which will make your motor generator vibrate.

273. What is a transformer?

274. Give some of the advantages of mazda equipment.

275. What will cause the bulbs to blacken, and what is the reason for the height of the glass bulb?

276. What is a prismatic condensor?

277. When using a prismatic condensor, will the condensor be closer to the aperture than if you use a plano condensor?

278. Using a small diameter projection lens, which condensor combination (prismatic or plano convex) will allow more light through the lens?

279. Can a prismatic condensor be used when running slides?

280. Describe how to start a mazda lamp in operation, and tell what happens at each step.

281. How close should revolving shutters be to end of lens barrel?

282. What would you use for a focussing card on a projector with a rear shutter?

283. Show how you would adjust the lamp and mirror to get a correct focus.

284. Give approximate distance between (a) center of mirror and filament, (b) filament and condensor, (c) condensor and aperture, (d) lens and revolving shutter.

285. When using a cinephor condensor system, is accuracy in the focal distance of much importance, and why?

286. What is the mirror image, and where should it be focussed?

287. What is meant by filament image?

288. How many filament coils has a mazda lamp?

289. When the mirror image is not properly focussed, what will be the appearance of the light on the screen?

290. Can a cracked mirror be used on mazda? What will the effect be on the screen? Can a cracked condensor be used?

291. How can you overload a mazda lamp, and will you derive any benefit from so doing?

292. What will usually result from overloading a mazda lamp?

293. What is meant by the term "sound picture"?

294. At what speed must a sound picture be projected to get correct reproduction?

295. What results are apparent in the reproduction when the projector is run at a lower speed?

296. What results are apparent in the reproduction when the projector is run at a higher speed?

297. How can the speed of the projector be varied on Western Electric or Northern Electric equipment?

298. At what speed does the turntable revolve?

299. Define a sound track film.

300. Define a disc film.

301. Why does the needle on the disc record travel from the center of the disc to the outside?

302. On the Vitaphone disc, is the actual sound record on the bottom of the track or groove, or is it cut into the walls of the groove?

303. What is meant by "drift" of the reproducer arm, and why is it used?

304. What might happen if the clamping weight is not secured on the disc, and the projector is in motion?

305. What is the "mechanical filter" on synchronous sound equipment?

306. What usually results from turntables not being level?

307. How often should a disc be used?

308. What is meant by a scratch filter?

309. What is surface noise?

310. How often should a disc be cleaned, and what should be used?

311. How often should a needle be used?

312. Suppose the needle continually jumps out of the groove, and on putting on a new disc the jumping continues, what would cause this, and how could you remedy it?

313. What effect on reproduction may a warped disc have?

314. How and where should discs be stored in the projection room?

315. How could you test a disc for warpage?

316. What should you do with a disc that is badly scratched?

317. On disc film, what is the "start mark"?

318. Why is the "start mark" used?

319. On disc film, why is each foot marked on the side of the film?

320. Define "footage marks".

321. Of what help to projectionists are the "footage marks"?

322. Do Technicolor films have footage marks?

323. Suppose you were projecting a Technicolor print and the film broke, piled up at the upper sprocket, and due to the brittleness of Technicolor was badly broken up, how could you put it in synchronism again?

324. Define synchronism.

325. What type of film must be used to replace any film removed, due to breaks, or for any other reason?

326. Tell how to splice a sound track film.

327. Which of the lines, the white or dark ones, make the actual sound from the film?

328. What is the difference between "variable area" and "variable density"?

329. What film producers use "variable density"?

330. What density does R.C.A. use in recording?

331. What is known as "motor-boating"?

332. What is the cause of motor-boating?

333. How can "motor-boating" be overcome?

334. What effect on reproduction may a poorly made sound track splice have?

335. Why should a sound track splice be painted out?

336. What causes surface noises on sound track film?

337. How should sound track film be cleaned?

338. What effect may a heavy scratch on the sound track have on the sound reproduction?

339. What effect may oil on the sound track have?

340. What type of paint should be used on sound track splices, and why?

341. How could you tell if any footage had been cut from a disc film if it suddenly went out of synchronism?

342. How would you proceed to restore it to sychronism?

343. Is the start mark on disc film of any importance?

344. What are storage batteries used for?

345. What apparatus do the "H" batteries supply with current on Western Electric or Northern Electric equipment?

346. What tubes do the "F" batteries supply?

347. What tubes do the dry "B" batteries supply?

348. What bad effect will a defective "B" battery have on sound reproduction?

349. How often should wet batteries be charged?

350. How can you tell when batteries need re-charging?

351. What is "specific gravity"?

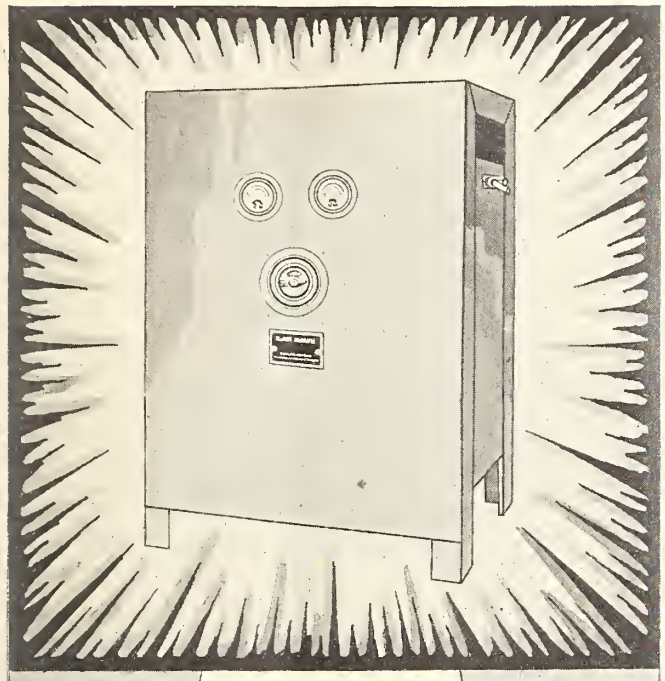
352. What is the use of a hydrometer?

353. What is "electrolyte" in storage batteries?

354. What may happen if there is dirt or water on battery tops?

(*To be concluded in July issue*)

FOREST
RECTIFIERS



FOR

GOOD PROJECTION

Forest Rectifiers are designed and constructed to meet the need for dependable rectification equipment. They are silent, and may be operated in the projection booth with sound apparatus.

The Forest M.P. 25-25 Rectifier, illustrated above, supplies steady, direct current of from 15 to 25 amperes to two projectors continuously.

All Types of Rectifiers in 15 amps., 25-25 amps., 30, and 65 amps., Sizes

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New and Wilsey Sts., Newark, N. J.

Adapters for
211-E . . 50 WATT *tubes*

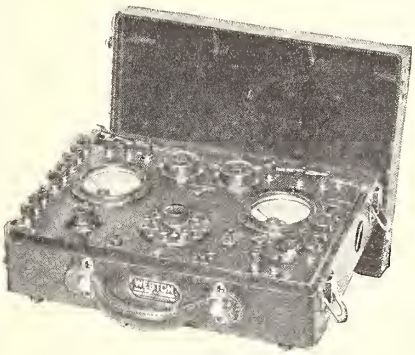
for use with

WESTON *SOUND APPARATUS* TEST SETS • MODELS 565 and 566

● Sound apparatus test sets are vitally necessary in the projection booth of the modern theater which features quality sound reproduction. Amplifier tubes, speaker-coils, batteries and the vast number of electrical circuits must be checked at regular intervals to assure continuous and satisfactory performance. For this work, the dependable, accurate operation of Weston Test Sets is invaluable.

● To make Weston Test Sets even more useful to the projectionists, Weston has designed an adapter which permits 50 Watt, type 211-E tubes, to be checked quickly and easily. It may be used with either Weston Model 565 or 566.

● Model 565 is a three meter test set. It is practically a portable testing laboratory. It makes every electrical test that might be necessary in the servicing of sound apparatus and the attendant equipment. It is recommended for the larger theaters.



Model 566

● Model 566 is a compact, light, relatively inexpensive two meter test set, designed to give the projectionist the necessary readings to intelligently service sound apparatus. Model 566 Weston Test Set is considered the standard equipment for servicing sound apparatus and public address systems.

FREE →
to Projectionists

A free "Copy of Instructions," showing how Weston Model 566 Test Set can be used, will be sent to all projectionists who request it on their theater's letterhead.

WESTON
ELECTRICAL INSTRUMENT CORP.
608 Frelinghuysen Avenue Newark, N. J.

ULTRA-SONIC VIBRATIONS

IN his recent evening discourse delivered at the Royal Institution Professor F. L. Hopwood discussed ultra-sonics or inaudible sound. Sound is, of course, produced whenever a vibrating body is placed in a material medium, whether the latter is a solid, a liquid or a gas. For sounds to be audible the vibrations must not only be of sufficient amplitude but also their frequencies must lie within the range 20-20,000. Disturbances of the same type as sound waves but having frequencies exceeding 20,000 vibrations a second are termed ultra-sonic.

Remarkable effects are obtained when sound waves of great intensity, and frequency of about half a million, are generated in an oil bath by means of a quartz crystal set into resonant vibration by a thermionic valve oscillator. Acoustic radiation pressure exerted on the free surface of the oil may raise in it a mound several centimeters or even inches in height, and cause it to erupt droplets like a miniature fountain. On plunging vessels of appropriate form into this mound of oil, vibrations of great intensity may be communicated to the walls of the vessels, or, through the walls, to liquids contained in them.

Following the methods of Langevin, Boyle and Wood and Loomis, demonstrations were given of reflection, refraction and interference of sound waves of short wave length; the production of bubbles and expulsion of dissolved gases from liquids; acoustic distillation; transverse vibrations in solids accompanied by anomalous movements of dust particles; flocculation of suspended matter and production of emulsions; acceleration of chemical action; pronounced thermal effects; remarkable effects produced on plants, bacteria, muscle nerve preparations, and on living organisms such as planaria and fish. —*Nature.*

▲

NEW COLOR FILM

LEARNED members of the Royal Society in London witnessed a demonstration on May 20, of the Spicer-Duffy three-color system of motion picture photography, for which the claim is made that it will revolutionize cinematography.

The secret of the new British invention, it is said, is that the actual film base is painted with a foundation or matrix consisting of 500,000 minute red, green and blue-violet squares—the three primary colors—to every square inch of film. Over this foundation is coated a highly sensitive emulsion. The film is then exposed in an ordinary camera and shown by an ordinary projector without any special attachment. The result appears to be a perfect natural color film which inventors have been seeking, which can be thrown on a screen, it is asserted, within an hour of photographing. The film, moreover, is non-inflammable.

▲

SELSYN-THYRATRON CONTROL

In the July issue of PROJECTION ENGINEERING will appear a complete description of the Thyratron rectifier tube—Selsyn method of control of stage lighting effects.

▲

MOTION PICTURE INDUSTRY

Compilation by Association of Motion Picture Producers based on figures available as of March 1, 1931, shows 17,097 picture houses in the United States, of which 13,515 are wired for sound reproduction. There are 28,454 theatres of all types in Europe, of which 7,720 are wired. Capital invested in motion picture industry throughout the world is placed at $2,500,000,000, of which $2,000,000,000 is in the United States. Introduction of sound necessitated an investment of $200,000,000 in this country. Motion picture industry rates as the fourth largest in this country.

▲

RECORDING EQUIPMENT IN CRIME INQUIRY

In the July issue of PROJECTION ENGINEERING will appear a complete description of the latest use of sound recording—in taking testimony and in securing confessions of crimes committed.

▲

PROJECTOR WITH SOUND ON DISC

In adapting a De Vry 35 mm. portable projector for sound on disc, it will be found that the normal speed of the 35 mm. projector is 24 frames per second or, in other words, the projector runs 1440 r. p. m. and the speed of the turntable is 33⅓ r. p. m. The star sprocket, however, operates on a one to four ratio with the projector or, in other words, it is running 360 r. p. m. when the projector is running 1440 r. p. m.

▲

"MOVING TALKIE" BRINGS DEAD LANGUAGE TO LIFE

(*Concluded from page* 13)

the muzzle of the gun. This is done by placing two pairs of magnetic coils at right angles on the neck of the tube near the muzzle.

Through one pair of these coils flows a current generated by a special vacuum tube oscillator located in the lower compartment of the oscilloscope case. The magnetic field produced by this current causes the bright spot to move back and forth across the screen. The motion from left to right is linear—that is, at a constant velocity—and the return from right to left is at about fifty times the forward velocity.

This whole cycle, in a typical case, lasts only one-thirtieth of a second and is repeated time after time so that the path of the bright spot appears as a bright, straight, horizontal line across the face of the cathode ray tube.

Now, if alternating current resulting from a voice wave striking the microphone is sent through the second pair of coils, the magnetic field produced by it will cause the straight line to bend itself into the exact shape of the wave of the alternating current.

Thus, the shape of any alternating current or voltage can easily be studied by connecting the current or voltage to the proper terminals of the oscilloscope panel.

▲

AN A-C. OPERATED PORTABLE TALKING PICTURE EQUIPMENT

(*Concluded from page* 17)

the power-packs that supply the current for the exciter lamp and the anode voltage for the p. e. c. The amplifier and air-column speaker are coordinated to give linear response over the entire frequency range. The safety factor is ample, allowing for excessive line voltage and overloads.

The output wattage is sufficient to operate two standard air-column speakers in an auditorium with a seating capacity for 1000 persons. The air-column speaker is supplied as a standard part of the equipment, although, whenever conditions demand it the baffle type dynamic cone speaker can be used to advantage.

Turntable Connection

Connections are provided to facilitate connecting a "non-sync" phonograph turntable for supplying dance or incidental music before and after a performance. A microphone for making announcements can be connected in the amplifier circuit.

Due to an unusual safety factor, continuous operation in theatres is possible without overheating. Two complete shows of 12 reels can be given without undue strain.

The portable amplifier is designed to operate with either one or two projectors. All controls are dual with exception of the volume-control. Changeover from one projector to another is accomplished by means of a switch. The volume is controlled by a balanced network and arranged in convenient steps providing for close control of sound.

All units are interconnected with cables which terminate in plugs conveniently marked.

A single projector unit consisting of a projector, an amplifier, a 6 x 8 screen and stand, an exponential horn and one set of cables, can be packed in three small trunks and weighs 350 lbs. A double projector unit weighs 450 lbs.

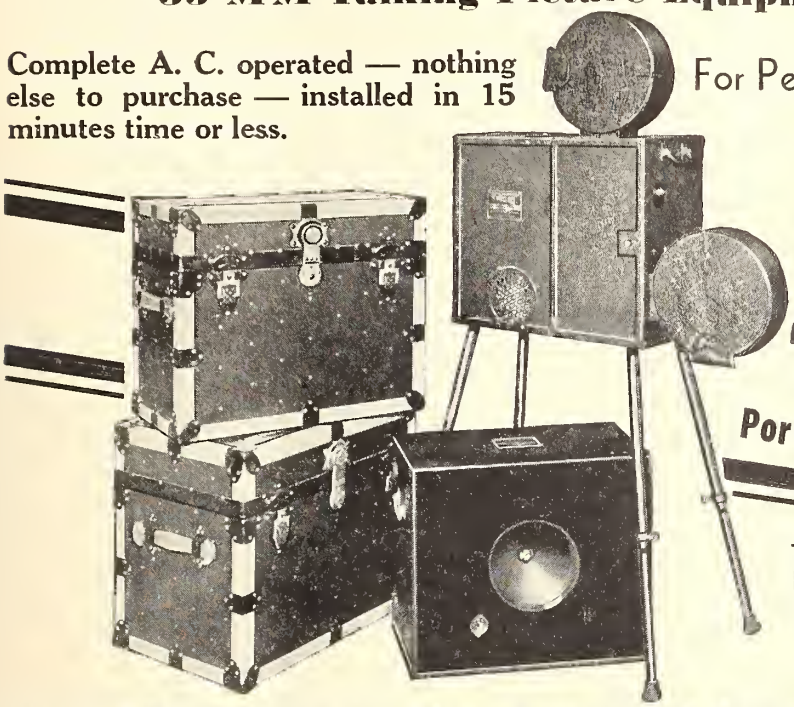
PHOTOTONE TALKAFILM

PHOTOTONE PORTABLE SOUND FILM

35 MM Talking Picture Equipment with Projector

Complete A. C. operated — nothing else to purchase — installed in 15 minutes time or less.

For Permanent and Temporary Installation



BUILT for Discriminating Purchasers That Must Have Quality Above Anything Else Both in Reproduction and Construction

The Standard Equipment in the Portable Field by which all are Judged

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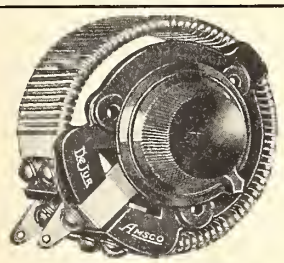

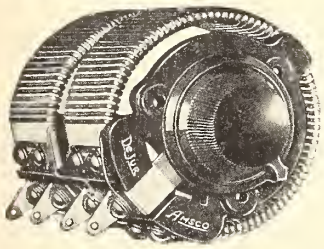

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95 Morton Street, New York City

New Developments and News of the Industry

THE VIGILANT SAFETY CONTROL

The Vigilant automatic safety control, manufactured by the Vigilant Safety Device Co. at Sharon, Pa., seems to be the most simple and neatest control on the market. Contrary to other makes of safety controls, the Vigilant does not use mercury switches, and operates on an open circuit instead of a closed circuit. Its operation is extremely simple as well as accurate.

Fig. 1 shows the automatic motor control switch and transformer housing. This switch is so arranged that when it is closed it latches and is held closed against a strong spring pressure.

Fig. 2 shows the Vigilant dowser arrangement. When this dowser is raised it also

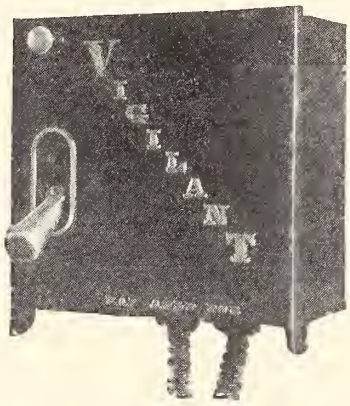

Fig. 1.

latches against spring pressure. One of the features of this dowser is that there are no electrical parts to it, and only a small steel wire running through a flexible cable is used to connect it with the rest of the control. A small button is arranged so that it may be released at will.

Fig. 3 shows a Vigilant film switch for a Simplex projector. This switch is held in an open position by the film, and makes

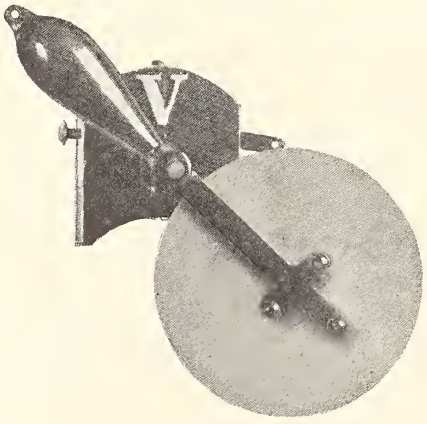

Fig. 2.

contact either up or down which takes care of the film breakage, or the loop taking up at this point, which is directly under the intermittent sprocket.

Fig. 4 shows the lower take-up switch for a Simplex machine. This switch is also

Fig. 3.

Fig. 4.

held in an open position, and should the film break just before it enters the lower magazine, or should the take-up belt break, this switch immediately closes.

The operation of the Vigilant safety control is as follows. The machine is threaded in the usual manner. When time to start the projectionist closes the Vigilant motor switch and raises the dowser in the usual way. In case trouble develops within the projector the small film switches close the circuit, which causes two magnet coils to release the latch holding the motor switch closed. This action allows the spring to open the motor switch, and at the same time pull the small steel wire running up to the dowser latch, causing the dowser to close. This entire operation is done in an instant.

▲

NEW PHOTOTONE PORTABLE REPRODUCER

A portable sound-on-film reproducing equipment, weighing less than 175 pounds and said to be the lightest, smallest and most compact apparatus so far developed for 35 mm. film, has been perfected by Laurence M. Corcoran, eastern sales manager for Phototone Equipment Corp. of Indiana, and will be placed on the market soon by this company. The device can be set up in 15 minutes by any layman, according to Mr. Corcoran, and packs into two small cases that will fit in an ordinary pleasure car. To operate the equipment, it is only necessary to plug into a light socket and turn on the switch.

▲

VICTOR ANNOUNCES RESULTS OF COMPARATIVE TESTS WITH 16 MM. PROJECTION LAMPS

The rapidly increasing demand for 16 mm. projectors capable of serving both the auditorium and small room requirements of schools and churches has made light a factor of major importance in the construction of the better projection equipments.

The lamp manufacturers have accomplished remarkable things in developing lamps to meet this demand. Due, however, to the limitations imposed by the small size of the T-10 bulb and of the optical accessories in the projectors, it appears that their creations in the low voltage, concentrated-filament type of lamp leave little, if any, room for major improvements.

Of these lamps, there are three that are contending for first place as being the best general purpose lamp for the majority of maximum illumination requirements.

These are the 165 watt-30 volt Mazda, the 250 watt-20 volt Mazda, and the 375 watt-75 volt which does not carry the Mazda stamp. That the watt-volt specifications on these lamps are somewhat confusing to the average layman is evidenced by the fact that "165 watts-30 volts" sounds like a comparatively low rating, whereas the lamp is actually equivalent in power to 605 watts in a 110 volt lamp.

The Victor Animatograph Corporation, Davenport, Iowa, offers a projector equipment in which any one or all of these high intensity lamps may be used interchangeably. The model 3G Victor Cine-Projector has a built-in transformer to accommodate the 250 watt-20 volt lamp. A change-over system of wiring permits the transformer to be cut out. By plugging-in with the No. 11 Victor lamp rheostat, the 250 watt-50 volt, the 165 watt-30 volt and the 375 watt-75-volt lamps may all be used in the same projector.

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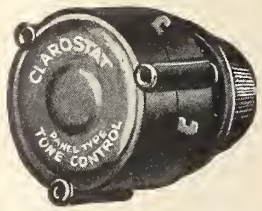
TONE CONTROL

The Clarostat Manufacturing Company, Inc., 285 N. 6th Street, Brooklyn, N. Y., is marketing a completely bakelite encased tone control for panel mounting. It has an



extra long threaded bushing with two nuts for mounting on any thickness panel or cabinet. A 3/8 inch hole is required. The unit takes up but one inch space behind the panel, and is 2 inches in diameter.

▲

HOME TALKIES

The Talkiola Corporation, 1600 Broadway, New York, is bringing to the market a home talkie equipment which combines a talking picture machine, using 16 millimeter film, together with a specially designed radio and phonograph. The cabinet is quite different from the usual radio type. It resembles a secretary and can be used as a desk when open.

The manufacturer had to develop and design a noiseless projector to take care of the increased speed of talking pictures over the silent pictures and at the same time eliminate noises which would interfere with the proper reproduction of talking pictures.

Talkiola has a radio perfectly matched to the pickup, which is specially designed for it and produces the rich, natural tone which you find only in the best of radios. By a quick turn of the dial you switch from the radio to the phonograph and can then play any record recorded at the speed of 78 r.p.m.

Shifting a lever changes the speed of the turntable from 78 to 33-1/3, which is the speed used in talking pictures.

The threading of the film is easily accomplished and the plate is so marked that any one can project a picture without technical knowledge or training.

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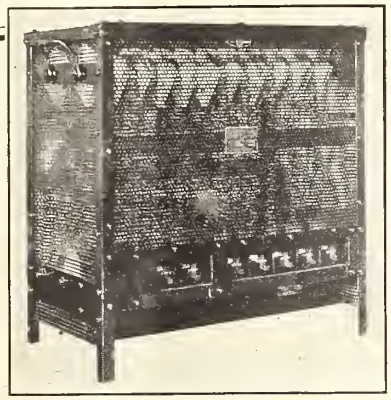
"There Is No Substitute For RELIABILITY"



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Making claims is one thing—Making good is another!

Projectionists and theatre owners who have installed Perfection Rheostats KNOW our guarantee means the best results—clearer pictures—longer life.

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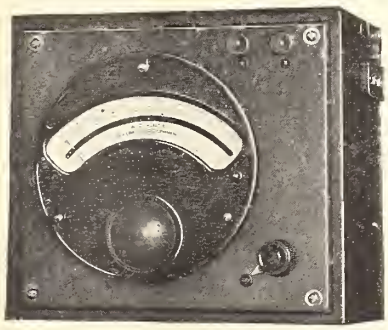

VACUUM-TUBE VOLTMETER

Because of its practically infinite input impedance and its freedom from frequency errors, the General Radio vacuum-tube voltmeter is ideal for development and maintenance work on high-quality sound systems.

The meter illustrated above is the Type 426-A Vacuum-Tube Voltmeter, range 0-3 volts. It is of the bridge type in which the internal plate resistance forms one arm of a resistance bridge, the indicator being a calibrated d'Arsonval movement. This construction makes for accuracy and permanence of calibration.

Price: $160.00

Bulletin 932-P6 contains a complete description. Ask us to send you a copy.

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CINEGLOW

the 3 element recording lamp

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Type T9
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For Any Standard Glow Lamp Circuit.

CONSISTENT — RELIABLE

Maximum Volume—Abundant Exposure—Without Distortion

Special circuits supplied with each lamp.

PRICES

Type T9 — 6 inches long — $50 each
Type T8 — 4 inches long — $40 each
Special discounts in quantities.

BLUE SEAL SOUND DEVICES, Inc.

130 W. 46th STREET, NEW YORK

SCREEN OF METAL MESH ON MARKET

After several demonstrations with good results, a new type metal mesh projection screen, under the trade name of "Lustro-Pearl" and designed especially for high grade theaters, has been placed on the market by the Mandalian Manufacturing Co., North Attleboro, Mass.

The features claimed for this new screen include: A surface treated with the purest of known chemicals, entirely free from gloss, eliminating distortion common to ordinary types.

Highest reflection factor known to reputable light testing laboratories, effecting a considerable saving of electric current.

Constructed to distribute sound very clearly and uniformly throughout the entire theater.

Can be washed with hot water and soft brush without injury to its surface.

Affords a clear view of any picture from any angle of observation, eliminating eye strain or discomfort to patrons.

Its high reflective qualities bring out objects in a manner which might be termed the nearest approach to three dimensional pictures, the company claims.

RKO Proctor's 58th Street, New York, is among the first houses to install this new type screen.

▲

ACOUSTICS AND SEATING BOOKLET

A booklet, dealing in acoustics and its relation to seating, and containing facts about reseating engineering service, is being issued by the American Seating Co.

▲

GENERAL THEATRES EQUIPMENT EARNINGS

Total of $4,454,405, after all charges, including interest, depreciation and taxes, is the net income of General Theaters Equipment, Inc., and its subsidiary companies for the year ended Dec. 31, 1930, the company stated recently in announcing its annual report. This is compared to $2,140,023, in 1929 had the subsidiaries now embraced by the company been operated by it for the full year. Portion of earnings accruing to General Theaters Equipment in the 1929 report was $940,296.

The 1930 earnings are equivalent to $1.57 per share on the 2,838,913 shares of old common stock. Deducting actual dividends on the new preferred stock, such earnings are equivalent to $2.23 a share on the 1,892,608 shares of new common.

Acquisition of controlling interests in Fox Film Corp. and Fox Theaters Corp. is reflected in the large increase in assets of General Theaters from $55,096,901 on Dec. 31, 1929, to $129,094,728 at the close of 1930. Current assets are figured at $9,732,-638, and current liabilities at $6,628,109, exclusive of a $10,000,000 note on a loan obtained for the purpose of paying for shares of Class A stock of Fox Film, and to provide funds for the acquisition of additional shares of Fox Film Class A stock. This loan is secured by 500,000 shares of Fox Film Class A stock and was renewed from April 10, 1931, the due date, to Sept. 27, 1931.

▲

TALKING MOVING PICTURES FOR THE HOME AT POPULAR PRICES

The field of home movies has long been well established—and has been emphasized by the interest displayed in talking moving pictures for the home, which have been a reality for several years.

Much new interest has been created in the announcement by the Sprague Specialties Company of Quincy, Massachusetts, of the Visivox, a home talking moving picture machine, priced far below any other item previously announced. This field has not only been complicated by high prices in the past, but also by the inavailability of 16 mm. talking moving picture films and records for either purchase or rental. There are now, however, numerous of such films and records available with regular production established, and the subjects range from a wide variety of educational pictures to all sorts of comedies, dramas and feature films.

There are two Sprague models, one portable and one in cabinet form. The portable type "Visivox A" lists at $119. This model includes the phonograph synchronization apparatus, pickup and projector. The user plugs a wire into his radio set, another into an electric socket, and the apparatus is ready to operate. Where no radio set is available, another small portable device, listing at $50, is attached to this model, thus providing the audio and loudspeaker. This latter instrument is known as Model "B."

"Visivox C" is a complete machine in a walnut cabinet, including projector, synchronical phonograph apparatus, amplifiers and loudspeaker. This lists at $189.

The Sprague Visivox is very simple in its mechanical operation and the synchronization is entirely automatic. Both types of machines play all sizes of phonograph records, including the 16-inch theatre records, and can be used separately as a phonograph if the moving picture apparatus is not desired. The Visivox may also be used as a simple projector of 16 mm. films where it is not desired to use it as a talking picture. Much significance will be attached to the popular prices which open this type of machine for a much wider sale than hitherto available.

▲

NATURAL COLOR FILM IS READY FOR QUANTITY PRODUCTION IN HOLLYWOOD AND NEW YORK PLANTS

Magnacolor, the new natural color film perfected and introduced by Consolidated Film Industries, Inc., after years of experimenting and consideration of many other processes is hailed as a superior and satisfactory color process that the industry has long been waiting for. It marks progress in motion pictures.

Magnacolor provides color pictures that can be produced and processed with the same facility, and that are as sharp and clear as black and white.

Magnacolor requires no change in present cameras and projectors except the use of Magnacolor films and a slight adjustment of the camera gate.

▲

RESISTORS FOR TELEVISION

The engineers of the International Resistance Company have been preparing from the standpoint of resistors for forthcoming television.

Special types of resistors are required, and the demands made upon resistors are in some cases more severe than in the conventional radio receivers because of the widespread use of resistance coupling in the amplifier portion of the television short-wave receiver.

The International Resistance Company Engineering Department is keeping as closely abreast of this interesting subject as is possible, and is cooperating frequently with manufacturers who have especial problems in this connection.

▲

VOLUME CONTROLS

The Central Radio Laboratories, 16 Keefe Avenue, Milwaukee, Wis., has issued a new bulletin illustrating and describing a line of volume controls for sound installations. The bulletin contains a considerable amount of engineering data valuable to engineers.

▲

THEATRE EMERGENCY LIGHTING

Roth Brothers & Co. announce a complete line of emergency lighting equipment to protect patrons from the dangers caused by failure of the lighting service.

The emergency and exit lighting circuits in theatres are normally supplied from the a-c. lighting service. In the event of a power failure, the Roth system automatically operates by gravity action and transfers the load to the storage batteries so rapidly that there is only a very slight flicker.

The load is also automatically transferred back to the a-c. supply, upon resumption of the normal power service.

The batteries are kept fully charged, ready for emergency use by means of electric clock control, so that they are always in condition to supply the load during emergencies. The plant has sufficient capacity to supply all exit lights for a period of 3 hours.

▲

PROJECTOR FOR SCHOOLS

International Projector Corp., has completed a new projector especially suitable for schools. The U. S. Navy has ordered a "large quantity" of these machines for delivery before July 1, this year.

▲

NEW VOLUME CONTROL WITH "DEAD" SHAFT AND BUSHING

Of especial value in the control of the new variable-mu tubes, the new Clarostat wire wound volume control with "dead" or insulated contact arm and mounting bushing has just been announced by the Clarostat Mfg. Co., Inc. of 285 North Sixth St., Brooklyn, N. Y.

This improved model 01 the Clarostat control makes the use of insulating mounting bushings unnecessary as all exposed parts are out of the electrical circuit.

It is supplied with a dust cover or not as desired and may also be had with 110 volt switch attached.

▲

GAIN CONTROL

The Type GL-35 gain control manufactured by Jenkins and Adair, Inc., 3333 Belmont Ave., Chicago, is of the potentiometer type, built up of nichrome wire resistance units of different values, totaling 350,000 ohms. The steps have a logarithmic increase of resistance which gives an equal gain in decibels per step. When used in a standard amplifier circuit these steps are approximately 3 decibels each.

▲

SILENCE FOR TALKIES

The variable speed fan drives, manufactured by the Horton Mfg. Co., 3016 University Ave., Minneapolis, Minn., make for quiet in sound-equipped theatres.

Controlled ventilation for theatres all the year through is necessary because the health and comfort of patrons require, and maximum results from sound reproducing equipment demand it.

It is economical because through easy starting, it eliminates fuse blowing and reduces belt wear. Through speed adjustments to atmospheric conditions, power bills are greatly reduced.

An average speed reduction of only 25% nearly halves the power bill. Records of the local power company at Fargo, N. D., show that to drive its fan, the Isis Theatre used 1975 kwh. electric current during four months before and only 1924 kwh. during the first full year after installing the Horton variable speed drive.

The owner, Floyd Junkin, advises that the variable speed drive made it possible to operate his fan constantly during every performance throughout the winter—a great deal of the time at just speed enough to prevent air stagnation and sound-defying air pockets.

Through the reduction of electric current used, the initial cost is quickly liquidated, after which the monthly saving is all profit.

▲

JENSEN SPEAKERS

A permanent magnet speaker known as Jensen model PM-1, and the first of a new line of dynamic speakers designated as model J-1 were shown and demonstrated at the RMA show, Chicago. They are made by the Jensen Radio Mfg. Co., Chicago. Copies of bulletin will be sent upon request.

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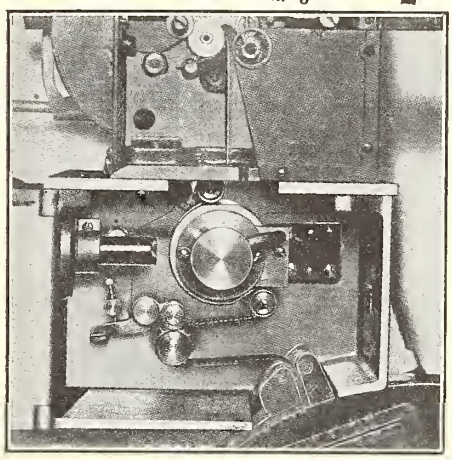

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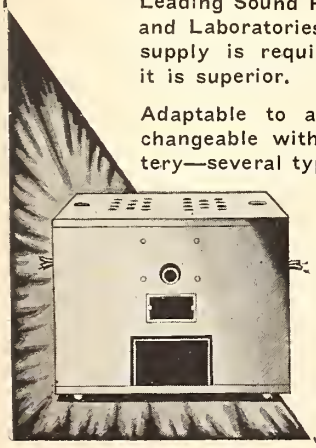

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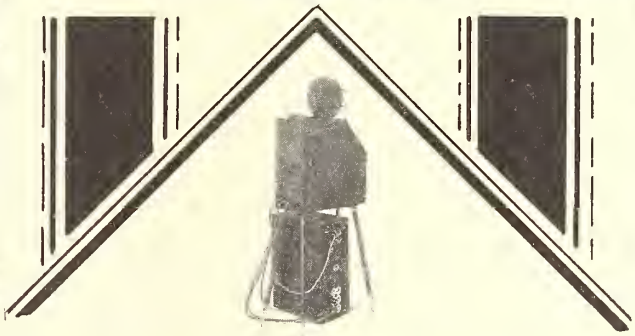

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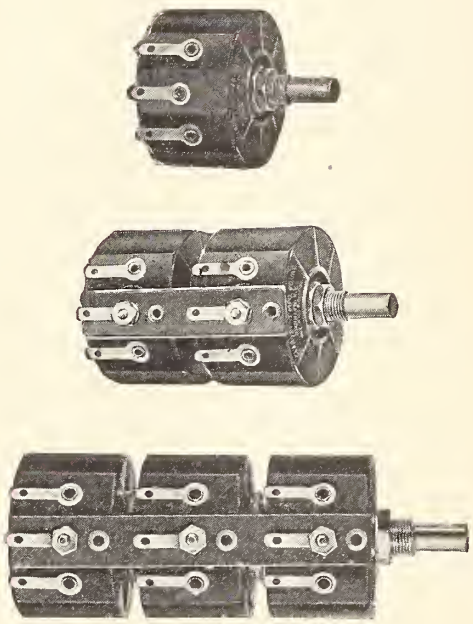

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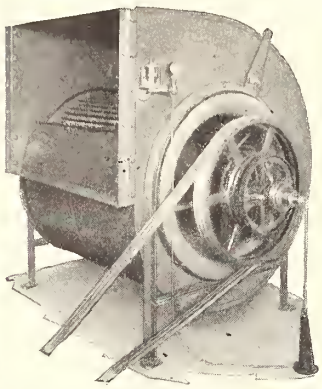

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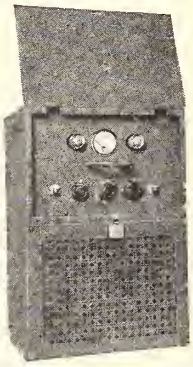

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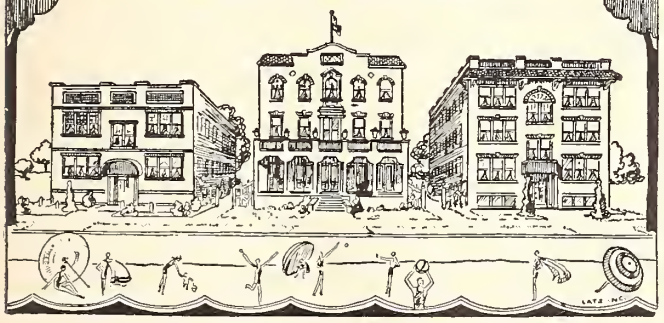

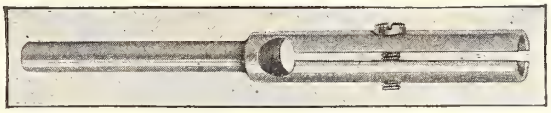

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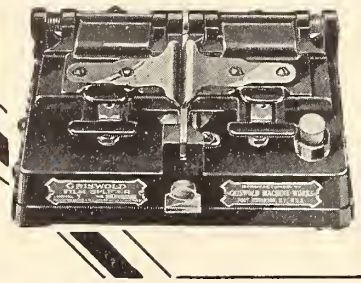

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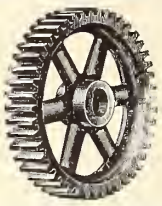

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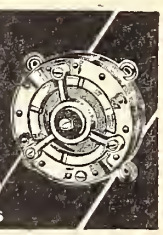

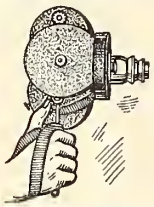

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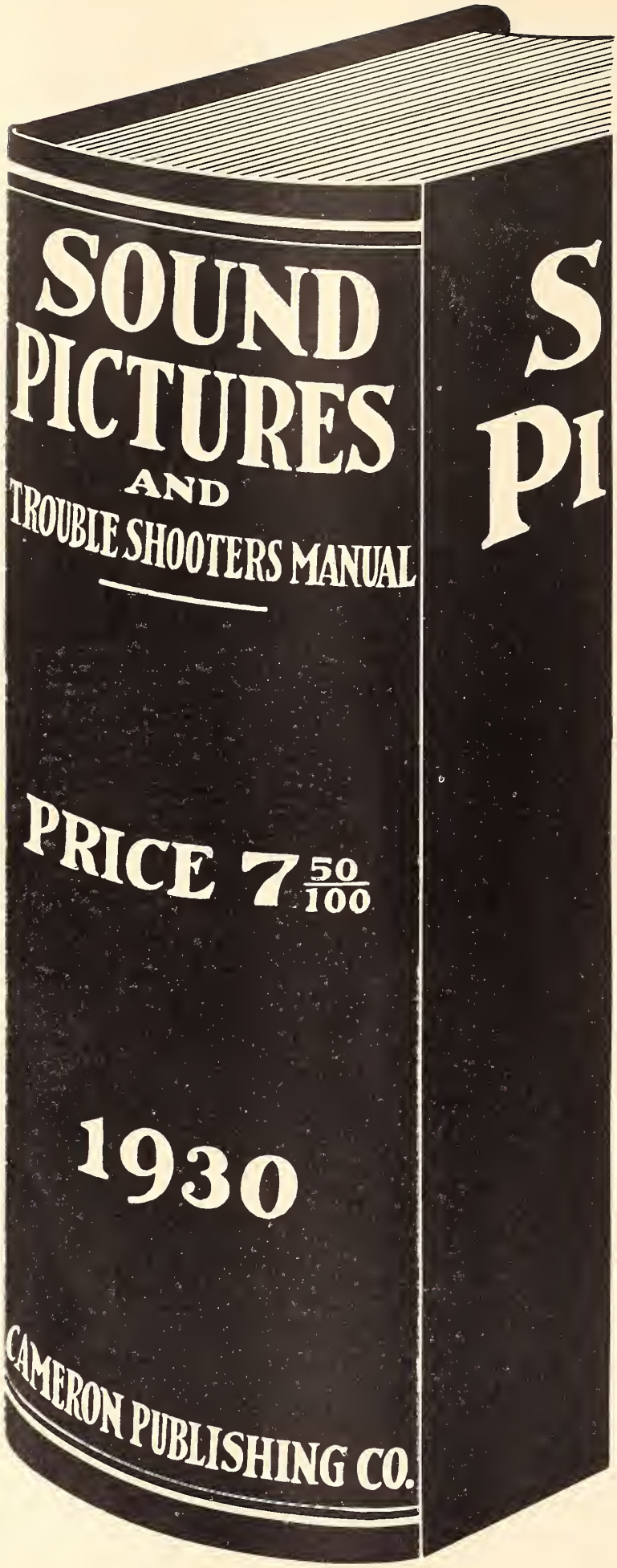

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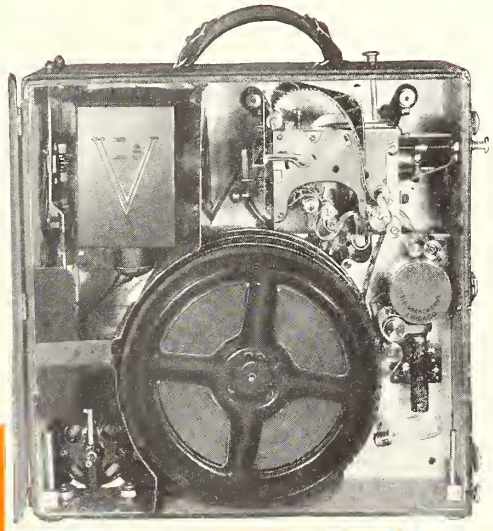

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AUGUST, 1931

PROJECTION ENGINEERING

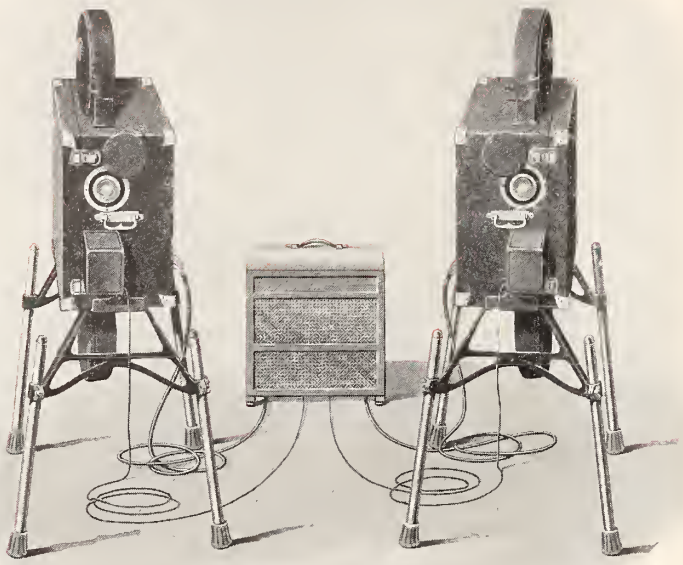
SOUND - VISUAL

(*Photo Courtesy Samson Elec., Co.*)

Rehearsal of "Mikado" directed by microphone and loudspeaker

THE JOURNAL OF THE SOUND AND LIGHT PROJECTION INDUSTRIES

Bell 35m.m. Portable Sound-on-Film Projector



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Vol. III — AUGUST 1931 — Number 8

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Public-Address Systems
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Photo-Voltaic Cells
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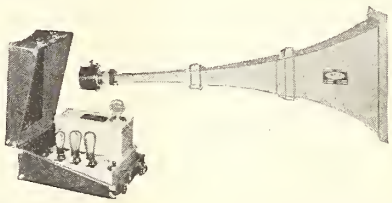

The strong wooden horn is made in three sections. It is 4½ feet in length, when extended for use, and 19 inches high when closed. The bell is 20″ x 20″ inside measurement. It is well braced and stands up under rough handling. Its highly polished interior preserves the quality and effects a penetration of sound not found in ordinary speakers.

Package No. 1, a fine imitation leather cabinet 8″ x 15″ x 19″, contains the microphone, 15-foot microphone cord, tubes and amplifier, weight, 40 lbs.

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The entire equipment can be set up in less than ten minutes. It is ideal for lectures, conventions and gatherings of every nature.

** Next month another important announcement will be made.*

Amplion Products Corporation

38 W. 21st Street New York City

Editorial

AUGUST, 1931

DOUBLE FEATURE SHOWS

A RECENT survey in New Jersey discloses that double feature picture presentations may very well be abandoned to the advantage of the exhibitor and with the approval of the public.

It develops that the most desirable patrons —those who attend theatres regularly—in large number think that a double feature show with all the program filler material lasts too long. Also, nine times out of ten it is but one of the feature pictures announced which attracts attendance.

Further, much of the word of mouth advertising a good picture should receive is lost when two feature pictures are shown, because of the confusion of mind natural under the circumstances.

A single three reel picture would seem to be the answer from the exhibitor's and the public's viewpoints.

Two feature pictures mean 104 pictures per year where but one change of program per week is made. There are not that many "feature" pictures produced.

▲

SENSIBLE COOPERATION

DURING the summer vacation months a large portion of the populace flocks to the shore resorts, the mountains and the lakes. In many of the vacation centers moving picture theatres are in operation during July and August. As these houses open up it follows that nearly a like number of theatres in cities and towns find it necessary to close because of decreased attendance.

In the case of the talkie equipped theatres there are the contracts for periodical servicing to be reckoned with, the charge for which ordinarily would continue whether the house is in service or dark.

This year a generous move toward considerable cooperation in this seasonal condition has been made by R. C. A. Photophone. Mr. J. H. Tingle of that company announces as follows:

"We are endeavoring to lighten the financial burdens of exhibitors who find it necessary to close their theatres. Many theatres close during the summer months and we have modified our previous policy by suspending service charges during the period when they are dark. Upon receipt of two weeks' written notice of intention to close, we shall send engineers to the theatre to service the equipment for the closed period and upon like notice prior to reopening will place the equipment back in service."

That this action will be duly appreciated by the managements of Photophone equipped houses may be taken for granted.

▲

NEW THEATRES

IT is in the architectural design of new theatres that full advantage may be taken of what has been learned about the shortcomings of "silent" houses for good sound reproduction. It is understood that it would not be difficult to design auditoriums capable of providing satisfactory sound effects in all seat positions if that were the only requirement, but there are other factors which must be given due consideration when theatres are planned.

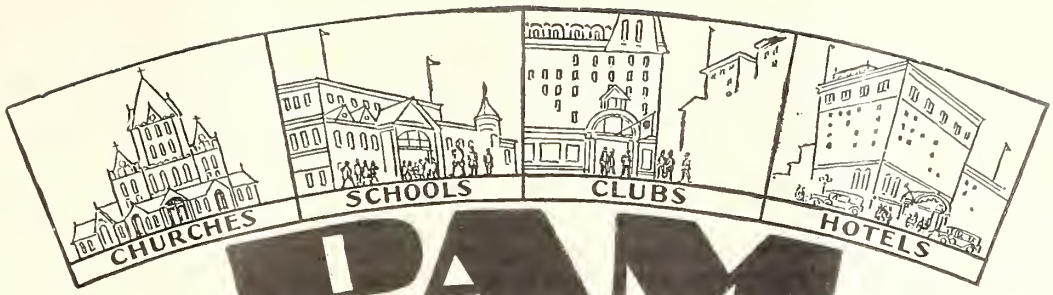
A theatre is designed to seat a given number of persons. It must be adequately ventilated. It must have beauty of decoration and appointments. It must be as fireproof as possible. Exits must be sufficiently numerous and convenient to afford rapid clearing in case of fire or alarm.

During the past two years much has been done toward improving the acoustics of many theatres and thought also has been given to improvement of vision.

The excellent paper presented at the Hollywood convention of the S. M. P. E. recently by Ben Schlanger contains some new and interesting ideas on this subject. The title of the paper was: "Reversing the Form and Inclination of the Motion Picture Theatre Floor for Improvement of Vision."

Donald McNicol

Editor.



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Portable PAM Address system to institutions that hold regular meetings and need the equipment permanently. This price is reasonable and the profits are large.

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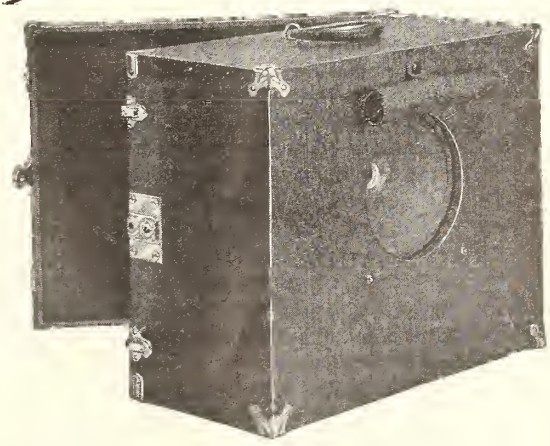
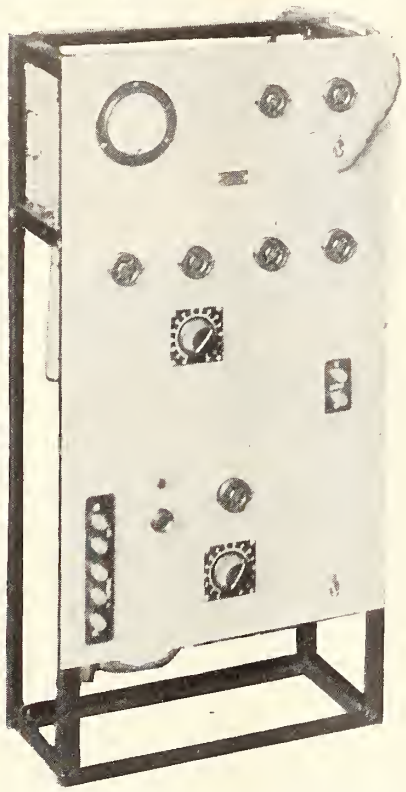


They must be good to be where they are!



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Projection Engineering

AUGUST, 1931

Applying public-address equipment to indoor use

By Gordon S. Mitchell*

As sound amplification equipment was developed and the industry progressed, attention became divided naturally along two major lines—out-of-door and indoor systems. While these two groupings of course embody the same principles of operation and apparatus, the development along each line has been so individual that it has become necessary to consider each as a unit. The equipment as applied to indoor use has by its very nature become of wider extent than in the related field of activity out of doors. Sound amplification equipment is being put to new uses every day —new ways are being found to apply the old apparatus, and new apparatus is being developed constantly to augment the usefulness of that already in service.

It may well be said that the development of the vacuum tube amplifier is largely responsible for the present state of development of the audible motion picture, inasmuch as the "all-talking, all-singing, all-dancing" production of the present day would still be in the embryonic state were it not for the high state of perfection of the amplifier. The development of the talking motion picture, in its turn, is in a great way responsible for the advancement to its present state, of indoor public-address equipment. While the modifications of such equipment as found today are largely a product of individual ingenuity, the entire idea of sound amplification was given great impetus by the pronounced success of the equipment as installed in the theatres for the projection of synchronized sound.

The orthodox public-address system as installed for the purpose of raising the volume level of sound in hall or auditorium may be considered as of first importance in any classification of equipment according to usage. It might be mentioned at this point that the operation of such a system indoors is in general less complicated than of an identical system in the open. The second type of system in any such classification is that installed in large buildings for the purpose of providing centralized controlled radio or musical programs to a multiplicity of outlets. These systems may be modified to provide facilities for picking up programs originating in public rooms in the same building or programs originating elsewhere and transmitted to the central output station by line wire there to be distributed about the building, as desired.

As the number of channels increase, the complexity of the system, hence the difficulties of installation and operation, increases in direct proportion. These systems range from a single channel which makes available one radio program to the guest through loudspeaker or headphone, up to the extensive multichannel system which makes available any one of several radio programs, a speech in a banquet room across the city, or the music of an orchestra playing in the supper room, to the guest, chosen at his own desire by the twist of a single dial mounted on the wall of his room. These systems, as installed principally in apartment houses and hotels, are rapidly becoming one of the marks of modernity by which a metropolitan establishment is judged.

School Room Use

Public-address systems as designed for schoolroom use embody points of similarity to the sound distribution system as found in hotels and apartments as well as the orthodox amplification system for hall or auditorium, in addition to characteristics of their own contributed by the very specialized use to which they are put. Due to the fact that schoolrooms are in general larger than the usual hotel room, the system as installed in a school will be operated at a higher volume level than would the same system applied to hotel and apartment usage (a volume which oftentimes approaches public-address level) yet the multiplicity of outlets makes these systems closely akin in many ways.

Three acoustic phenomena enter into consideration when installing an indoor public-address system. Of these three, reverberation is probably of first importance. When reverberation time becomes so great that the reflected sound embodies two distinct impressions, we are conscious of an echo in the hall or enclosed space under consideration. The time lag between sounds may be cut down by drastic acoustic treatment of the space, much in the manner of lowering the time of reverberation (by increasing the number of "absorption units" which in turn is increased by increasing the area of absorptive material about the space). Blind spots and their associated echoes are not often encountered in halls or rooms of rectangular or other regular shape, but are found almost entirely in rooms having curved or domed ceilings or walls. It might be mentioned in passing that when such a condition is the result of architectural defects — (architectural characteristics which would be classed as defects when considered from a purely acoustic standpoint, such as a domed

Electrical Engineer, Sound Department, Universal Pictures Corp.

▲

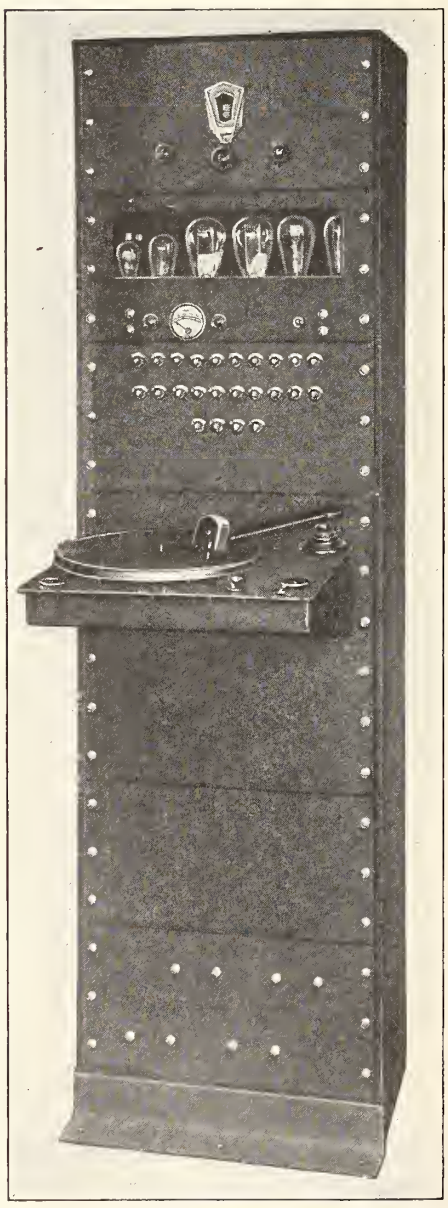
The rapidly increasing opportunities for public-address installations make it important that engineers and installation technicians study all of the factors.

ceiling) the condition can never be entirely eliminated but can be improved to a great extent by an acoustic treatment of the space. Experimentation in the placement of the loudspeaker can also many times do much to minimize the effect of domed ceiling or curved walls. The microphone should never be placed in proximity to regions of localized echo due to curved walls of ceiling. However, it may be advantageous at times to place the loudspeaker in such a position that the curved surface will act as a sounding board, tending to spread the sound throughout the space. However, these are purely local problems, peculiar to each individual installation and solvable only after a study of the particular installation has been made.

Foreign Noise Disturbance

The problem of foreign noise, as encountered in indoor systems, is mainly a matter of microphone placement. The microphone should be placed near enough to the speaker or other source of desired sound to maintain at all times sufficient differential between the desired and the undesired sounds so that the desired sounds will be suitably intelligible. Consideration of this factor of the public-address problem may best be given by an illustration of the difficulties encountered and the results achieved in a recent installation. The function was a dinner, given for the purpose of congratulating a political candidate on his recent success in election. A hall had been hired, and the committee in charge had made their preliminary plans as to the location of the speakers' table, other tables, space for dancing, and so forth. As set up by those unfamiliar with the problems of sound amplification, the hall embodied a very bad feature with regard to foreign noise concentration. As planned by the committee, the speakers' table was to be placed across one end of the room, with the remaining tables spread about the edge of the space in front leaving the center of the room cleared for dancing. The doors leading to and from the kitchen opened into the hall directly in back and to each side of the speakers table, while the main entrance to the hall from the outside was at the far end of the room. It was then planned to rent a small public-address system, equipped with a microphone pickup for increasing the volume of the speaker's voice (the hall was rather long and narrow and notoriously acoustically bad) and a radio pickup for providing dance music later in the evening. The committee had planned to place the microphone on the table before the speaker, grouping several loudspeakers near the ceiling and at the same end of the hall. However, after calling a sound engineer into consultation and heeding his advice, the setup was entirely different from that planned previously.

The speakers' table was placed across one side of the hall, the remaining tables being placed at each end leaving the space immediately in front of the speakers' table cleared for dancing. Had the speaker been placed with his back to the kitchen doors, the microphone would have faced this definite source of foreign noise, and the system would have operated very unsatisfactorily. The projectors, as installed, were placed in three groups, one group being placed near the ceiling at each end, consisting of three receivers each, while a separate small projector was placed high on the wall near the kitchen doors for the purpose of increasing the volume level of the desired sound at this point and minimizing the effect of the foreign noise emanating from the kitchen. This grouping of projectors also eliminated the possibility of singing which would be present were the projectors placed above the speakers' table, due to the tendency of any amplifying system to howl if the mouths of the loudspeakers are placed behind the microphone. The system, installed in the recommended manner, operated entirely satisfactorily throughout the festivities.



(Courtesy, Amplex Instrument Laboratories, New York)

Rack and panel used for school sound installation.

Special Applications

It might not be amiss to pause at this point and consider a very specialized type of installation which is often encountered. There are many small restaurants and tea rooms which desire to give their patrons music with meals, yet are unable to afford the expense of an orchestra. The installation of a sound amplification system, using as sound source either recorded selections or radio pickup, solves the problem very nicely and at small expense. Because of the fact that these places are usually small, and acoustically good due to the abundance of soft surfaces throughout the space (table covers, wall hangings, carpets, and clothing of patrons) the only factor which enters into consideration is the matter of foreign noise. The level of extraneous noise is usually very high in these places, contributed by the rattle of dishes, conversation of patrons, etc., hence an amplification system will have to be operated at a higher level than is usually necessary. However, to avoid a concentration of sound in one portion of the room and such low volume that intelligibility is bad in another, it is better practice to place several smaller loudspeakers about the space, operating each at somewhat lower volume than would be satisfactory were one only used. This gives even volume distribution throughout the entire space. As a practical point, it might be brought out that if these speakers are placed high up near the ceiling, the system can be operated at lower volume level than if the projectors were situated at table top level, due to the fact that absorption is less when so located.

Sound Level

Best results will be obtained with indoor installations if all projectors are connected to one volume control dial, thus maintaining a level throughout the space. Regions of insufficient volume should be corrected by the installation of small booster horns, or by repointing adjacent projectors, but not by raising the volume level in nearby horns. This is in contrast with the procedure of operation of out-of-door systems, which by reason of shifting wind, changing weather conditions, etc. during actual broadcast (broadcast as used herein is in connection with the transmission of sound by radio, the only difference be-

ing in the vehicle of transfer of energy from transmitter to projector) makes manipulation of volume level of individual projectors during the broadcast necessary. No such factors enter the consideration of indoor systems, and it is best operating procedure to control all projectors from one volume control.

It has been said that the ultimate success of a public-address system may be judged by the degree to which the listener is aware of the mechanical-electrical aid being given by the system. Judging the system by a measure of the extent to which the system intrudes itself upon the listener's consciousness is in general good practice, and may well be given as a comparative "yardstick" by which various systems may be judged. Consequently, the system should always be operated at as low a volume level as is consistent with intelligibility.

Quality in any sound system, whether it be radio broadcast, sound recording for motion pictures, or phonograph, or public-address, may be said to be perfect when the transmitted sound contains all, and no other, frequencies which are contained in the sound as it strikes the microphone, and when those frequencies contain the same relative intensities which they had in the original before transmission. If a person speaks in a normal tone of voice, his voice will contain an abundance of the lows, but if he raises his voice, these lows will be attenuated and his voice will seemingly rise in pitch. This may be applied to common experience by all—when we shout, and the louder we shout, our voice appears to rise in pitch and becomes unpleasantly shrill.

Although the average person would be unable to explain the effect, the phenomena is known by instinct provided that person is blessed with normal hearing. If any sound system is interposed between the source of sound and the listener which disturbs this balance between frequency components and volume, the listener will be instantly aware of the unnaturalness whether he is aware of the psychological reason for it or not. If the projector which is transmitting the sound be operated at such a volume that the listeners instinct tells him the speaker should be shouting although he be actually speaking in a normal tone of voice, the system appears to make the voice seem heavy and unnatural due to the apparent overabundance of low frequencies. The more faithful the reproduction by the system, the more noticeable is this effect. Consequently it is good operating procedure to regulate the volume so that the farthest person in the hall is enabled to hear comfortably, yet not to allow the volume to become any greater than necessary. (This effect may be further eliminated by grouping the projectors in smaller groups about the space instead of in one group in a central place). In this connection, also, it is well to remember that if the volume be of insufficiently high level, certain of the weaker speech sounds will be lost and the general intelligibility lowered.

Certain buildings have long been famous for their architectural beauty, both inside and out. However, it is an unfortunate circumstance that it is those characteristics which most contribute to the interior beauty of an edifice which are also responsible for, in great measure, the poor acoustic conditions found in many beautiful buildings. Suitable public-address equipment may be installed in these buildings and will improve hearing in the public rooms to such a degree that perfect hearing will be possible in the farthermost portion of the space. Many large churches and cathedrals which have long been famous for their beautiful architecture have only been slightly less renowned for the difficulty experienced in hearing services within their auditoriums.

Church Installations

The installation of public-address equipment in a church will immediately fulfill two definite functions. It will improve hearing conditions and thus lessen the strain upon the collective auditory mechanism of the congregation, and will improve speaking conditions for the pastor, allowing full attention to be placed upon the text of the message as well as lessen the vocal strain. The installation of sound equipment is being looked upon with favor by many congregations, and a considerable number of churches which are being erected are being equipped with amplification systems at the time of their construction.

A rather large and well known church in Southern California, confronted with the problem of poor acoustics, looked to the installation of a sound system for relief. Extreme size of the main auditorium coupled with a very high vaulted ceiling, was mainly responsible for the difficulty experienced in hearing messages from seats in the rear portion of the hall. A microphone was placed near the pulpit, and two small sized booster horns installed near the ceiling and approximately two-thirds of the way back, for the purpose of augmenting the sounds as they came from the pulpit direct. This setup fulfilled the purpose for which it was made. Increasing popularity of the services made the provision of an overflow hall advisable, so a separate transmission line was taken from the amplifier to two projectors which were placed in a small adjoining hall, and those who were unable to find accommodations in the main auditorium were taken care of in this second room. Further increasing the usefulness of the system as installed, it was decided at the request of one of the elderly members of the congregation to provide earphone leads from the amplifier to earphones placed in certain pews, to be designated by the ushers as reserved for those persons who are hard of hearing and who desired artificial aid. This system has been operating for a period of some twelve months and has proven satisfactory in solving the acoustic difficulties of the particular church.

Call Systems

Another specialized use to which public-address equipment may be put is for the purpose of providing a call system for large organizations, the personnel of which may be scattered over one or more large buildings. Such a system, consisting of a central microphone, an amplifier and loudspeakers placed in the designated localities, provides a very handy means of calling any desired person to the central point. Sound equipment for this purpose has recently been installed in one of the large western research laboratories, consisting of a microphone in the central office and a loudspeaker outlet in every research technician's office or lab. When any one of these men is needed in the front office, the telephone girl, by throwing a switch places the system in use and speaks the man's name with the information as to where he is wanted, etc. into the microphone. This obtains an instantaneous response, and is more satisfactory than the old style method of calling by bell or buzzer signal. The response to a spoken word, especially if that word be a man's own name, is much quicker than is the response to a certain number of buzzes coming over a signal system. In addition, the buzzer necessitates every man stopping work while he counts the number of buzzes, while the spoken name coming over a small loudspeaker commands immediate attention of the one called, his fellows being enabled to continue with their work.

The above are only a few of the specific applications of public-address equipment to indoor use. Sound amplification, as applied to this particular portion of the field of public-address, has done much to increase the enjoyability of modern life and the efficiency of modern business. Although progress in the past has been marked, greater advances may be looked for in the future due to the increasing flexibility of equipment as it is being developed in the sound laboratories and in the field. Public address is the youngest offspring of the Sound family, and by some considered as having the best prospects for great future advancement. It is certain that great steps forward will be made in the matter of possible applications of equipment to new use in the coming months.

The acoustic treatment of auditoriums and halls

By E. F. Smith*

In this article are discussed the fundamental engineering considerations which make possible satisfactory indoor sound projection

IN ORDER properly to understand the subject of acoustics it is well first to be sure that a fair understanding of sound has been accomplished. Sound is a physical phenomenon which is understood by the psychologist to mean a sensation conceived within the brain as transmitted by way of the organs of hearing. To the physicist it is merely an atmospheric disturbance and is purely mechanical. With this tangible physical idea we are mainly concerned. Thus sound is caused by a body which is in a state of vibration or oscillation. If the body vibrates as a unit, all parts moving in the same direction and velocity at the same time, it sets up what is known as a pure or simple tone. If it vibrates in parts, that is, one part vibrating independently of the others, and the parts not being in synchronism, it sets up a complex wave. These waves, of course, are in the form or compressions and rarefactions of the air about the vibrating body. The complex consists of a pure wave known as the fundamental, and any number of superimposed waves known as overtones. These overtones give the various sounds their characteristics of timbre, quality, roundness, and other distinctive traits recognizable by the human mind.

As stated before, sound is caused by a vibrating body, whether it be made of iron, wood, glass, human vocal cords, or anything else. The sound resulting from the compressions and rarefactions of the air about the body radiates out from it as a center in the form of concentric spheres whose radius is constantly increasing. The velocity of these spheres varies with the medium of transmission, but its value lies somewhere around 1,075 feet per second in air. This value is determined by atmospheric conditions such as temperature, pressure, humidity and wind.

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The frequency is the number of complete vibrations the body makes in a given time, and the term cycle is used to denote such vibrations. Frequency of tone or of pitch is designated in cycles per second. The human ear cannot detect all frequencies. The lower limit of ear response varies with the individual but lies generally in the octave between 16 and 32 cycles per second. When the pitch is below the response limit of the ear, the brain no longer receives the idea of sound but witnesses a physical sensation, perhaps even pain, if it is heard at all. The ear likewise cannot detect sounds having a frequency lying above the octave between 16,000 and 32,000 cycles per second, this value also depending on the individual.

All Frequencies Needed

For true reproduction of mechanical sound, all frequencies must be present, but all frequencies are not entirely necessary to give intelligibility to speech. This intelligibility range lies somewhere between 700 and 1,100 cycles per second. In other words, without this range being reproduced, it would be very difficult or even impossible to understand the speech. With only this range present the voice would have little character—one would be able to understand it and that is all. In order to be able to distinguish one voice from another a wider range of frequencies is necessary. The frequencies necessary for this are those lying between 200 and 3000 cycles per second. These ranges are satisfactory only where understanding of the conversation and recognition of the voice are necessary, but a program of music, for instance, having all frequencies below 200 cycles cut off and all above 3000 likewise eliminated would be very unsatisfactory and would be definitely rejected by the public. The average person unknowingly demands every frequency covered by his ears to be present in any mechanically produced sound program. The frequencies must not only be present but also must be reproduced at a volume corresponding to that at which the other frequencies are produced. If certain frequencies are produced at a little higher level than the rest the whole sound combination assumes an artificial aspect, and produces what is known as distortion.

When a sound is produced at some particular point we noted before that it traveled away from the point in ever-enlarging concentric circles. This idea only holds true where there is unlimited space such as out on a broad field in the open. When a surface is placed within the range of this emanating sound which strikes it, part of the sound continues on its way in the new medium of the material of construction of whatever object was placed in the path. However, like light, the sound waves enter the medium, at least a part of them, and in doing so their speed is changed and their angle or direction of travel is changed. As the wave proceeds through the medium and into another, say back into air, a corresponding change occurs. Furthermore, like light, some of the sound wave is reflected backward upon the original wave. In this case the angle of incidence is equal to the angle of reflection, as in light waves. There is also another effect not found in the case of light waves, that is, when the sound strikes an object on one side, it may cause the whole object to vibrate in sympathy with the incident sound, and the vibrating object may cause a sound of its own to be set up on both sides of it, that is, on the side toward the original vibrating body, which will appear like a reflection, and also on the opposite side, which will appear like a passing through of the original sound Obviously, if an attempt is made to separate these effects, a very complex problem will result. This is unnecessary for our purpose but it is well to know that such conditions exist.

The subject of reflection is the one which we are probably most concerned with when we consider that the best light reflecting surface runs somewhere around ninety-five per cent efficient while there are sound reflecting surfaces which can reflect more than ninety-eight per cent of the incident sound. The sound energy which passes into and through an object, and that which sets the object into vibration is considered in this work as being absorbed by the material of the object.

Interference

Closely interlinked with this subject of reflection are those of interference and reinforcement. When the sound is reflected back upon the original wave in such a manner that some of the fre-

quencies fall into step with originals, or with others traveling away from other reflecting surfaces while some meet in such a manner as to cancel each other, we have what is called interference. Interference causes distorted effects in speech and music. If conditions are such that the reflected sound is of proper intensity and direction we may get an overall effect of reinforcement, and even in some occasional cases we may have almost complete cancellation. There are on record cases of buildings having almost perfect reinforcing properties as in the case of the Mormon Tabernacle in Salt Lake City, and in the various whispering galleries throughout the world. There are also cases on record where buildings have acoustic properties such that a speaker cannot be heard although the auditor is standing only a few feet from him. Such extremes are usually not common but instead we have a mixture of the two effects in the same structure and the net effect is troublesome.

The simplest auditorium is a flat field in the open. The speaker is located a little above the audience so that auditors near him will not obstruct the sound flowing to auditors in the rear of the assembly. When this is the case, there is no reflection and therefore no reinforcement, no cancellation, and consequently no distortion. Every sound which must reach the auditors must be produced by the vocal chords alone and must be of such intensity as to provide enough volume to reach each and every one of the listeners. If we should put a roof above the assembly we would find that most of the sound which first emanated into space would be deflected downward by the ceiling and this would help the original voice of the speaker so that he would not have to talk so loudly. If, however, the assembly stretches backward away from the speaker to such an extent that there is a noticeable difference in time between the original voice and the reflected voice, the distant auditors will have difficulty in distinguishing the separate syllables in words and the

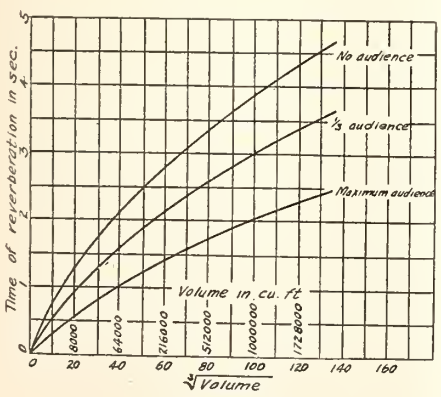

Figure 1.

speech may not be understandable. If a back wall is now added, there may be more difficulty or there may be still better results. When the other three walls and floor are added we have a common type of auditorium. It is evident from the foregoing reasoning that reflection is a desirable feature if we can control it in such a manner as to make it meet the requirements.

Volume and Reflection

There is a relationship between the volume of the sound and the reflecting properties of an auditorium. This is best shown by citing a case of a building the construction of which was followed rather closely. During construction it was not uncommon to witness a worker standing on the stage talking to another man who was almost at the top of the second balcony. His voice was understandable though he spoke in a moderately loud voice without shouting. When this theatre was completed it had very heavy sound absorbing material covering all the walls and ceiling. It also had heavily upholstered seats and thick carpets with lining. It was noted then that a speaker standing on the stage and talking in a very loud voice could not be heard in the second balcony except to know that he was speaking. On the other hand, when a public-address system was brought into play, the voice broadcasted from it could be heard almost perfectly in all parts of the house. This building had been designed to be acoustically correct for the large volumes of sound necessary to fill its immense cubic volume. A house which has too much absorbing material gives a "flat" effect and is termed "dead." One which has too little absorbing material gives a ringing effect and is termed "reverberant." Neither type is desirable but there must be a combination of the two effects to give good results.

Next we may pass to the problem of absorption. Everything absorbs a certain amount of sound whether it be made of iron or of wood, or if it be a chair, a table, drapery, carpet, or any other object. When we consider the acoustic properties of a building with a mind toward treatment we must consider all equipment in place within the building, or at least within the acoustic volume. Even the number of persons that will be present will have to be estimated and taken into account to obtain anywhere near satisfactory results. The unit of absorption has been taken as the absorbing power of an opening one foot square, such an opening having ability to absorb nearly all incident sound since it merely passes through to the opposite side. All other materials have coefficients which are comparisons between a square foot of the material and this standard absorber of sound. For instance, celotex has a coefficient of .31. This means that it would take 31 square feet of celotex to absorb as much sound as would pass through an opening having an area of ten square feet. A person has an approximate coefficient of 4.6 units. Seats vary in absorption between 1.0 and 3.5 units depending on the type of upholstering. Hence, the difference between the value for a person and the value for the seat he occupies will determine the difference in absorbing qualities of the building when he is present and when he is not.

Reverberation

When a steady sound exists in a room and is suddenly stopped, the time which elapses between the instant the sound ceases and the instant the prevailing sound can no longer be heard is called the "time of reverberation." Sabine, the well-known authority on acoustics, developed an expression for this time of reverberation as follows:

$$t = .05 \frac{V}{a}$$

in which t is the time of reverberation in seconds, V is the acoustic volume in cubic feet, and a is the absorbing power per square foot of the exposed materials in the room or auditorium. This formula is purely empirical and was based on observations made in many auditoriums. A rather complete list of coefficients for materials of every type can be obtained from the various manufacturers. A few of these are listed below:

Audience, per person.....	4.6	units
Wood seats, reg. audit., each	.10	"
Carpet, unlined, per sq. ft...	.15	"
Celotex, per sq. ft.....	.31	"
Glass, per sq. ft.....	.03	"
Concrete, per sq. ft.....	.015	"
Brick, 18 in. thick, per sq. ft.	.032	"
Wood sheathing, per sq. ft..	.061	"
Plaster, per sq. ft.....	.034	"

A very involved mathematical proof was then developed to find the ideal conditions of reverberation for an auditorium. The necessity of this was, as seen before, due to the fact that too little reverberation as well as too much is detrimental to the results obtained. The values thus found were plotted on curves as shown in Fig. 1, and then these curves were checked by comparing points thus found with those determined from a vast number of auditoriums which have been accepted by the public as being ideal.

Acoustic Material

With this data available it is possible to proceed with the designation of acoustic material which is to be used in any building. It has been found that the time of reverberation varies approximately as the cube root of the

acoustic volume and this is the reason why the reverberation time, t, was plotted against the cube root of the volume, V, in the foregoing curve. Taking assumed data for an auditorium having 120,000 cubic feet of acoustic volume we next assume the number of square feet of the various materials of construction. In the case of an already existing auditorium these values would, of course, be directly measured and the absorption coefficients of each material would be determined from suitable tables. Shrewd judgment of these values will be attained by experience in this type of work. Tabulate these figures as follows:

Plaster, 4,000 sq. ft. at .025.	100 units
Wood, 10,000 sq. ft. at .065.	650 units
Brick, 4,000 sq. ft. at .032..	128 units
Celotex, 3,000 sq. ft. at .31..	930 units
Seats, 500 at .1.....	50 units
	1,858 units

If one person has an approximate absorption coefficient of 4.6 units, and when present this person practically covers a seat having a coefficient of .1, the net change in the absorption makes the apparent value per person 4.5 units. Hence:

Absorption, furnished by materials, as above.....	1,858 units
Audience, 1/3 present at 4.5.	765 units
	2,623 units

Again:

Absorption furnished by materials, as above.....	1,858 units
Audience, all present.....	2,250 units
	4,108 units

The cube root of the volume, 120,000, is 49.3. This value corresponds to a reverberation time of 2.4 seconds for no audience, 1.8 seconds for 1/3 audience, and 1.2 for maximum audience, as shown by the curve as being ideal. Using the above data and substituting in the formula, $t = .05V/a$, we have:

For no audience

$t = .05 \times 120{,}000 \div 1858 = 3.2$ secs.

For 1/3 audience

$t = .05 \times 120{,}000 \div 2623 = 2.2$ secs.

For maximum audience

$t = .05 \times 120{,}000 \div 4108 = 1.4$ secs.

Comparing these values with those taken from the curve we have:

For no audience

3.2 instead of 2.4 for ideal conditions

For 1/3 audience

2.2 instead of 1.8 for ideal conditions

For maximum audience

1.4 instead of 1.2 for ideal conditions.

For maximum audience we find that the value pretty closely approximates that for ideal conditions, but for 1/3 audience we see that there is a considerable deviation. Likewise, there is also a wide difference between the two values for the condition of no audience. However, the low percentage of audience will be found more often than an empty house or than a full house so that it is advisable to correct to this value rather than for empty house conditions. Taking the value of 2.2 seconds as ideal for one-third audience, we can substitute in the formula, whence we have:

$$2.2 = .05 \times 120{,}000 \div a$$
$$a = 2727 \text{ units}$$

At one-third audience the absorption was found to be 2,623 units, so that an addition of about 105 units will have to be added to bring the reverberation time down to the ideal condition. If we assume that celotex or other similar material is to be used to supply this additional absorption it will have to be placed over some other material already in place, unless there is some baffle wall arrangement. If we assume that celotex has a coefficient of .31 and that the wood which it will replace has a coefficient of .065, the net coefficient will be .245 units. Therefore, we will have to use $105 \div .245$ or approximately 430 square feet of celotex, which will cover over the wood which was included in the original calculation.

Frequently an auditorium will have peculiar characteristics such as a bad echo in the rear of the upper balcony, or a false sound source in the boxes. One theatre was noted as having a large oval dome in the ceiling about in the middle of the orchestra seats which were in front of the balcony. When a speaker was on the stage and a listener is seated within an area about ten feet wide and twenty feet long just in front of the stage, the latter receives the illusion that the speaker is located up in the dome in the ceiling insofar as the sound is concerned. The reflected and concentrated sound is so much greater than the original that the latter is not noticed. In a case of this kind it would be best to cover the dome with absorbing material, or, if architectural beauty requires that it remain, its inner surface could be replastered with special acoustic plaster or otherwise covered in such a way that the reflection will be killed. Many other cases require individual treatment such as those effects caused by extensive flat walls, niches, standing rails, glass panels, doors, ventilating grids, etc. The process usually followed is that of breaking up the surface or covering it so that reflection will be reduced to a minimum.

Another matter for consideration is that of residual noise, that is, noise which is normally always present. Under this heading comes a variety of sounds such as ventilating fans and the motors that drive them, the rush of ventilating air through the ducts and grids, steam heating systems which have inherent hissing sounds or those emitted from leaking joints or which have driving motors whose vibrations and rumbling is transmitted to the auditorium by way of the piping, noises made intermittently by trolley cars, automobiles, horns, railroads, or subways, and this latter group transmits rumbles for many blocks, and other similar ones. Under such conditions a speaker must talk louder to be heard above the noise, or in the case of mechanical reproduction the gain of the amplifiers must be increased or the attenuation decreased. This is known as "masking" the noise.

The audience itself makes much noise even when trying to be quiet. This noise is caused by breathing, rustling of clothing, moving of feet, etc. Such noises cannot be eliminated to any great extent, though the noises caused by moving feet are effectively lessened by the installation of carpets in the aisles and foyers or in some cases of extreme scuffling it has been necessary to install cork tile throughout the house.

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E. O. HEYL ADVANCED

A. E. REOCH, executive vice-president of RCA Photophone, Inc., announces the appointment of E. O. Heyl, vice-president in charge of foreign affairs, to the office of vice-president and general sales manager to succeed Sydney E. Abel, who recently resigned as head of the commercial department.

During the past eighteen months, Mr. Heyl's activities have been confined to the corporation's interests in foreign fields in which he has had a broad experience. He became identified with RCA Photophone, Inc., in 1928, following extended association with a number of the country's leading industrial organizations. During the World War he was, with Julius Rosenwald, the noted Chicago philanthropist, a member of the council of national defense and later became a division head with Herbert Hoover when the latter assumed charge of the United States food administration. Mr. Heyl brings to his new position a rich background and broad experience in merchandising in this country and abroad.

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THE DEPTH OF FIELD OF CAMERA LENSES

THE above is the title of a paper preted by Arthur C. Hardy, at the recent Hollywood meeting of the S. M. P. E. In this paper the usual formulae for depth of field are expressed in terms of the focal length and relative aperture of the camera lens. By expressing the depth of field in terms of the magnification between the object plane in sharp focus and the film, a very simple and rigorous formula results. This makes it evident that the depth of field of all lenses giving the same magnification is the same under comparable conditions.

What happens within the bulb of a radio tube?

By Linwood G. Lessig*

In this article Mr. Lessig presents an easily understood, sound technical explanation of the operation of vacuum tubes as used in radio and audio circuits.

THE most important single device known to radio science is the thermionic vacuum tube. It consists of a glass bulb generally somewhat similar in appearance to an electric light bulb. The bulb contains a heated electrode (acting as a source of electrons) and additional electrodes, such as the grids and plates, which number ordinarily from one to four. Special tubes may employ additional electrodes, depending upon the service for which the tube is designed. In general, radio tubes are evacuated to a high degree, although there are some that depend upon a very small amount of gas for special characteristics.

The simplest type of tube is the two-electrode type. It contains a filament and a plate sealed in an evacuated glass bulb. The plate is made electrically positive with respect to the filament by means of a battery in the plate-to-filament circuit. Nearly all modern receivers (and transmitters) are designed to use two-electrode tubes for the purpose of converting alternating current to direct current which is then used for the plate, grid and screen supplies of three, four and five electrode tubes. Sometimes two separate filaments and two separate plates are mounted in the same bulb. This construction permits the rectification of both halves of the alternating cycle. Such tubes, which are really two tubes in one, are called full-wave rectifiers. The effect of rectifiers on alternating current is shown in the waveforms of Fig. 1.

*Commercial Engineering Department, RCA Radiotron Co., Inc.

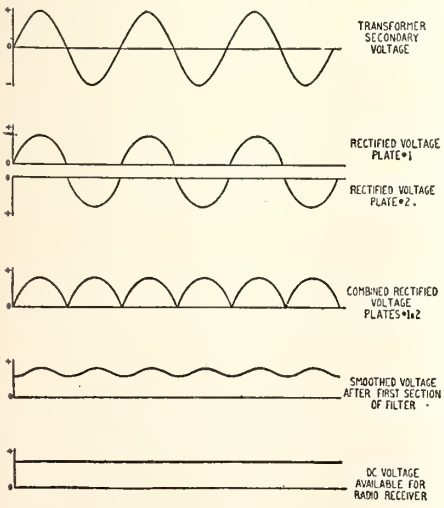

Fig. 1. Full-wave rectification.

The Operation of a Two-Electrode Tube

When the filament is heated it produces a cloud of electrons around it. If the temperature of the filament is gradually raised by a slowly increasing current from the "A" battery (filament supply), electronic emission will correspondingly increase. This action may be explained as follows.

Heat provides the energy to accelerate or stir up electrons. When the temperature of a filament is gradually raised, then, with each increase of temperature the electrons gain in velocity, and finally, the electrons will have acquired sufficient energy to make themselves useful in a radio tube. They are projected into the space surrounding the wire. This action is known as electron emission.

Since electrons are continuously streaming in every direction from the filament, it is obvious that there are at every instant a number of electrons in the space between the filament and the plate. They move toward the plate and are literally absorbed by it while additional electrons are emitted at the same rate by the filament. The quantity of electrons in the space between the filament and plate depends upon the rate of absorption by the plate and upon the filament emission. An increase of the filament temperature increases the electron emission from the filament, and, therefore, the number of electrons present in the space between the plate and the filament. This "cloud" of electrons collectively produces a negative charge which in itself has a tendency to retard new electrons attempting to leave the region of the filament. It is known as the *space charge* effect.

With a fixed filament voltage (which produces a definite filament temperature) more and more electrons will be drawn to the plate as the voltage of the latter is increased—up to a certain point. Beyond this point additional plate voltage has little effect in increasing the plate current, because all of the electrons emitted by the filament at the given temperature are being drawn to and absorbed by the plate. This maximum plate current is called *saturation current,* and because it is an indication of the total number of electrons emitted, it is also called the *emission current,* or, simply, *filament emission.* When this condition has been reached, however, the plate current can again be increased by the use of a higher filament temperature. For any given temperature of the filament in a perfect tube, there is a corresponding maximum value of plate current. This maximum value is obtained when the electrons are drawn over to the plate as rapidly as they are emitted from the filament.

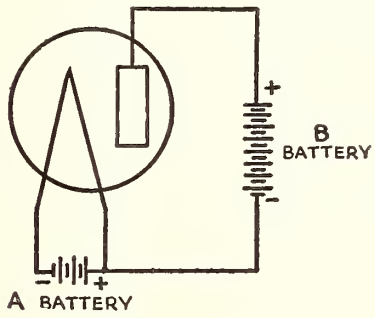

Fig. 2. Elementary diagram of the circuit connections of the two-electrode vacuum tube.

Three-Electrode Tubes

It has been shown that the plate current may be influenced by changes in either filament temperature, plate voltage, or both. Another factor which will influence the flow of plate current is the effect of an electric charge on a third electrode in the tube. The third electrode which is placed between the filament and plate is called the *control grid* or merely *grid.* A diagrammatic representation of a three-electrode tube is shown in Fig. 3.

When the grid of a three-electrode vacuum tube is made positive, or negative, with respect to the filament or cathode, the plate current will correspondingly increase or decrease. The grid is located relatively nearer to the filament than it is to the plate. Thus, a small voltage change on the grid will have the same effect on the plate cur-

rent as a larger voltage change on the plate. A grid in performing this function requires very little power, serving merely as a valve to control the comparatively large amount of power in the plate circuit.

A negatively charged grid tends to force the space electrons back toward the filament. This effect decreases the plate current. Plate current, in fact, may be reduced to zero (cutoff) by making the negative grid charge sufficiently large. On the other hand, when a positive charge is applied to the grid, the electrons are accelerated and increased plate current results. Radio tubes are generally operated with negative voltage on the grid. The amount of this voltage, called grid bias voltage, depends somewhat upon the circuit in which the tube is designed to be used. The battery used to supply this grid bias voltage is called a "C" battery. See Fig. 2.

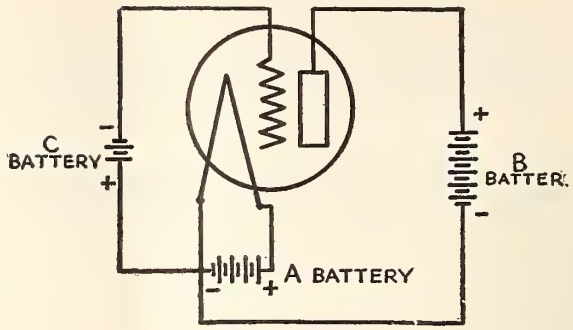

Fig. 3. Elementary diagram of the circuit connections of the three-electrode vacuum tube.

Interelectrode Capacity

When a three-electrode radio tube is functioning in a circuit its *input circuit* is considered to be from grid to filament and its *output circuit* from plate to filament.

The electrodes of a vacuum tube form an electrostatic system, each electrode acting as one plate of a small condenser. The capacities which exist are the grid-to-plate, the grid-to-filament and the plate-to-filament. The largest and the one most often considered is the capacity which exists between the grid and the plate. Its effect tends to produce coupling between the input and output circuits. Such coupling is often sufficient to cause undesirable feedback in the form of oscillations and general instability under conditions of high amplification.

Screen-Grid Tubes

Several schemes for minimizing this effect are offered. The first scheme is the use of special circuit arrangements to counteract or neutralize the coupling due to interelectrode capacitances. The second method is to eliminate, or nearly eliminate, grid-to-plate capacity in the tube itself. This is accomplished by employing the screen-grid tube. Intricate circuits and neutralizing difficulties are thus practically eliminated. In general practice the grid-to-plate capacity is reduced from approximately 8.0 micromicrofarads ($\mu\mu$fd) in the three-electrode tube to 0.01 $\mu\mu$fd., or less, in the screen-grid tube. This permits stable amplification of many times that of three-electrode tubes. The screen-grid type consists of the usual electrodes and an additional grid called a "screen" which is used as a shield around the control grid and serves to "screen" it from the effect of the plate. The construction is shown in Fig. 4.

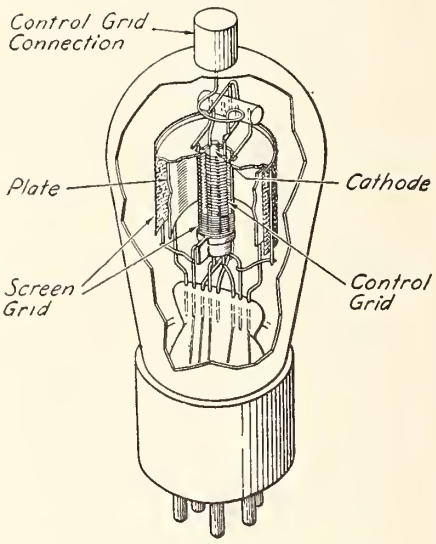

Fig. 4. Screen-grid type drawn to show construction.

It is undesirable to completely screen the plate from the grid since some electrons must get to the plate through the grid for normal operation. The screen is fixed at some positive potential lower than that of the plate. The electrons from the filament proceed toward the screen at considerable speed. Many of them go through it and are collected by the plate, provided the plate is at a higher potential than the screen. Because of the interposition of the screen between the plate and the grid, the rate at which electrons go across the space is not controlled so much by the plate voltage as it is by the voltage on the screen and grid. In other words, changes of plate voltage above the screen voltage have little effect on plate current.

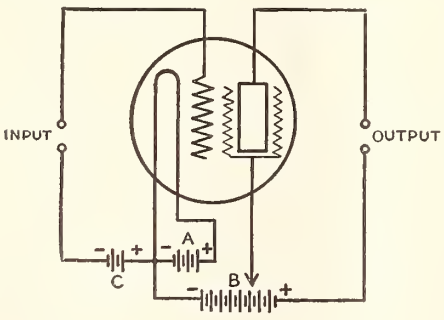

Fig. 5. Elementary diagram of the four-electrode (screen-grid) connections.

Secondary Emission

At plate voltages lower than the screen voltage, electrons may come from the plate and go to the screen, thereby causing the current to the plate to actually decrease. This backward-flowing current is due to *secondary emission.* That is, an electron from the filament may get through the screen, but at the plate it dislodges an electron which is dragged back to the screen because of its greater positive potential.

ACOUSTICAL SOCIETY MEETS

MORE than two hundred distinguished engineers, music technicians, and sound experts from all over the country attended the annual meeting of the Acoustical Society of America recently in Camden, N. J.

The sessions, in RCA-Victor Auditorium, opened with a symposium on musical instruments including papers by Dr. William Braid White, American Steel and Wire Company; Prof. Otto Ortmann, Peabody Conservatory of Music; Prof. Dayton C. Miller, Case School of Applied Science; and Leslie N. Leet, Aeolian Company. A. V. Bedford of RCA-Victor read a paper on "A Planetary Reduction Gear System for Turntables."

The morning sessions of the second and last day were taken up with a symposium on the history, development and uses of microphones, including papers by H. A. Frederick, Bell Telephone Laboratories; Stuart Ballantine, Boonton Research Corporation; E. C. Wente and A. L. Thuras, Bell Telephone Laboratories; Harry F. Olson, RCA-Photophone; O. B. Hanson, National Broadcasting Company, Dr. Irving Wolff and Frank Massa of RCA-Victor and E. W. Kellogg, of RCA-Victor.

Prof. Dayton C. Miller, of Case School of Applied Science, was elected president of the society; Dr. C. W. Hewlett of General Electric, vice-president; Wallace Waterfall of Celotex Company was re-elected secretary, and Dr. E. E. Free was re-elected treasurer. E. W. Kellogg of RCA-Victor, was elected a member of the executive committee.

Output matching to loudspeaker

By B. Brown, B.Sc.Eng.

Satisfactory sound reproduction in theatres and in other auditoriums and halls necessitates correct matching of output tubes and loudspeakers

WHILE in all standard sound systems the method of impedance matching is employed throughout design and the user has nothing to do with it, yet in many cases a knowledge of the principles involved is of considerable value. This is especially the case where additions or modifications to existing apparatus have to be carried out. In the following short article, therefore, some practical notes are given on the subject of matching the output tube of a low-frequency amplifier to a loudspeaker. Although the principles remain similar no matter what type of speaker movement is employed, we shall concern ourselves mainly with the ordinary moving coil or dynamic unit employing a paper or buckram cone in contradistinction to the small enclosed type of receiver where a diaphragm of aluminum or similar light alloy is employed.

In the first place it is well known that the output tube determines the actual power delivered a speaker. Providing the tubes are not used in parallel or similar arrangement the number of them has no effect whatsoever on the maximum possible output. Suppose it has been decided to fit a low-frequency amplification system to a certain room. How then is the power required to be determined in the first place? It is common to express the maximum power of an amplifier in undistorted watts output and in this connection it may be taken that for home use an output of 1½ watts is sufficient for a moderate sized room. For a café of medium size a larger output is naturally employed and in this case 4 or 5 watts should prove ample. For a small cinema, 15 watts would be suitable, but here the first complication is encountered. A well-known theatre sound system has an output of only 24 watts which is capable of filling practically the largest auditorium extant. How is it then, that the largest possible cinema requires an output not more than twice that of smaller halls? The answer is simply that the system in mind is an efficient unit capable of converting approximately 30 per cent of the electrical output into sound energy, but the ordinary type of loudspeaker with which we are dealing has a much lower efficiency. Care must be taken to avoid confusion in this matter and using the latter type of loudspeaker it may be taken that an output of approaching 50 watts would be required for a really large auditorium.

Estimating Wattage

There is a very simple method by means of which the approximate wattage output of any output tube may be determined. In the case of the triode the formula is simple:

$$\text{Output in milli-watts} = \frac{\text{Anode volts} \times \text{anode current}}{5} \text{ in milliamps.}$$

For the modern pentode tube a different constant has to be used and the formula then becomes:

$$\text{Output in milli-watts} = \frac{\text{Anode volts} \times \text{anode current}}{3} \text{ in milliamps.}$$

Thus supposing that the anode volts were 1,000 and the current 80 milliamps, in the case of a triode the output would be 16,000 milliwatts which is equivalent of course to 16 watts. The greater efficiency of the pentode is too well known to require discussion here.

Considering the above formulae it is evident that there are two means of obtaining greater power. We may use either a high anode current, or a high voltage. For portable radio sets where the weight of high tension batteries is of considerable import, output is usually determined by a fairly high anode current. In the case of fixed amplifiers and general sound systems, high voltage is usually preferable.

It must be emphasized, however, that this tube output is only obtained when the tube itself and the loudspeaker employed are correctly matched together. Impedance matching is a step of paramount importance to the designer and user of amplification, but strangely enough although understood in theory is not very well appreciated as a definite practice. Perhaps a simple mechanical analogy may make things clear. Consider the wires running from the output tube as pipes supplying a fluid and in a similar manner suppose the loudspeaker to be a water pump or similar device requiring coupling thereto. If these two pipes are of different size, then at the junction we shall have considerable loss of power due to eddy motion and to the conversion of potential into dynamic energy or vice versa as the case may be. Apart from this it is evident that unless the two pipes are of approximately the same diameter or are coupled by some smoothly tapered union we shall not get a uniform flow of fluid and thus are bound to lose efficiency. Such a coupling is in many ways analogous to impedance matching. When a loudspeaker and output tube are properly matched as regards impedance, it may be considered that there is a uniform flow of speech current from one to the other resulting only in the smallest of losses. Bad matching, however, causes considerable loss in power and at the same time may greatly mar reproduction as we shall show later on.

Efficiency Rule for Impedance Matching

The conditions for correctly matching the impedance of a loudspeaker and output tube are theoretically quite simple. All that is required is for the impedance of the loudspeaker to equal double that of the output tube. On the face of it the proposition seems simple, but actually, this is rarely the case. The impedance of an output tube is a fairly definite quantity and may be determined by reference to the data slip provided with it, or by manufacturers' catalogs. Loudspeaker impedance, however, is an entirely different matter and is not a perfectly definite quantity unless the particular frequency at which the value is taken is also specified. The d-c. resistance of the speech coil of a loudspeaker is practically valueless as a guide to its probable impedance and should be disregarded. Impedance itself depends on so many conditions that it is out of the question to attempt to calculate the values.

In a table are given the impedance values of a small type of moving coil speaker in which the diameter of the speech coil itself is approximately 1 inch and the d-c. resistance 4.41 ohms.

The diameter of the cone of this speaker is only about 8 inches and it happens to be of popular American manufacture. A cursory glance at the figures indicates immediately the very large variations in impedance according to the frequency at which it is taken.

Speaker Impedance

Taken with field current on; d.-c. resistance = 4.41 ohms.

Frequency	Resistance
100	4.6
200	4.7
500	4.9
1000	5.3
2000	6.6
3000	7.5
4000	8.4
5000	9.4
6000	10.4
7000	11.3

Imagine now the power of the triode tube being delivered at a particular impedance which then is obviously equal to a certain frequency. Thus the speech output is to a large extent at least concentrated about this particular frequency where the maximum volume will occur. If we couple a tube to a loudspeaker, automatically the output of the former is delivered to the latter chiefly round about a frequency corresponding to an impedance double that of the tube. It is therefore at this point that maximum volume occurs tapering off in both other directions. It is evident from this that improper loudspeaker and tube matching introduces accentuation of certain frequencies which in bad cases can be described as nothing less than distortion. Besides this since the band of frequency covered by any amplifier is limited, then if the matching is very bad this band may be raised or lowered in the frequency scale to such an extent that actual cutoff occurs and, besides, the tone of reproduction being high or low, we lose some of the range. This latter fact is one which is not always appreciated. Very often it is said that the matching of tubes and loudspeakers is simply a matter of taste. To a certain extent this is true but only so long as the frequency band of the amplifier is low compared to that of the loudspeaker. When both amplifier and loudspeaker are of good design their frequency ranges should be approximately the same and in this case correct matching is absolutely essential if no frequencies are to be lost.

It is customary to match the impedance of output tubes and loudspeakers at a frequency of approximately 256 cycles per second which is equivalent to Middle C in the pianoforte scale. Within limits of say 50 or 60 cycles plus or minus, tastes may be exercised but if maximum efficiency is to be obtained greater latitude cannot be permitted.

The rule of impedance matching therefore may be taken as:

(Impedance of loudspeaker at 256 cycles) = 2 (impedance of output tube). The figures of loudspeaker impedance on different frequencies are usually obtainable from the manufacturers of reputable apparatus and it is certainly not advisable to attempt matching without this data.

Neglected matching is not (as might be expected) always so evident to the human ear. Actually if the loudspeaker impedance be too high for the tube, then there will be a loss in top notes accompanied by an accentuation of bass. In a similar manner if the loudspeaker impedance is too low the tone of the speaker will be shrill and appear almost as though a pentode output tube was being employed, without the usual type of filter circuit to remove its peakiness. Quite a reasonable degree of efficiency in matching may be obtained by interchanging either tubes or loudspeakers until pleasing reproduction is heard, but this demands a musical ear of the highest quality which very few of us possess, and even then cannot always make due allowance for the limitations of mechanical reproduction.

Two Tubes

The foregoing remarks have been confined to the case of a single output tube working direct into a single loudspeaker. We have now to consider the case where two tubes may work in parallel into a loudspeaker. In this instance the paralleling of the two tubes halves their effective impedance and allowing for this factor the rule previously given may be applied. The addition of a tube by lowering the impedance value at the same time drops what we might term "the center of gravity" of the music and thereby causes loss in top notes. The general tone of the loudspeaker will thus be lowered but usually it is extremely difficult to judge this by the ear since the second tube besides making alteration in pitch also doubles the output. Projectionists have often noted with some surprise that the removal of a single tube from a parallel output makes no apparent difference in the volume in the auditorium. Actually, of course, it reduces the volume by 10 per cent but this is not readily discernible to the ear especially when smaller noises are in evidence. Actually, however, if one concentrates on the pitch of the sound rather than its volume a change may usually be perceived.

Two or More Loudspeakers

If speakers are placed in parallel their impedance is lowered. Thus, if two speakers are paralleled the impedance is halved while if three be treated in a similar manner the effective impedance is one-third that of a single speaker, assuming that each one of these devices possesses similar characteristics. On the other hand, if speakers are placed in series their various impedances are added. Keeping this fact before us the rules given some paragraphs back may still be utilized for the purposes of matching. It is now possible to make due allowance for multiple output tubes combined with multiple speakers either in parallel or in series circuits.

Output Transformers and Chokes

Straightway it may be said that placing a 1-1 transformer or non-tapped choke between the output tube and the loudspeaker makes no difference whatsoever in impedance matching and for this purpose may be completely ignored. The only reason for the insertion of such a device is to prevent the heavy anode current passing through the speech coil of the loudspeaker.

When, however, the transformer ratio differs from unity or a tapped type of choke is employed the conditions are entirely different as also are the reasons for the employment of the devices. The reason for the use of step-down transformers or tapped chokes is simply that of impedance matching itself. An examination of the characteristics of popular output tubes and dynamic loudspeakers will show immediately that these do not fit in with one another. If, therefore, we were determined to work without any type of coupling between them we should have to employ possibly loudspeaker units and output tubes of indifferent efficiency. In other words, we should not be in a position to employ the most satisfactory components.

Generally speaking, when considering modern sound systems we have already decided upon a suitable output tube and type of loudspeaker. The only step which requires determination is that of selection of a suitable coupling device so that the impedance matching between the two shall be correct. Step-down transformers are practically always employed with moving coil loudspeakers unless they happen to be of the now obsolete high resistance variety. By means of output transformer we have artificially to raise the impedance of the loudspeaker so as to make it suitable for matching the tube. The output transformers where employed for this purpose are always of the step-down variety. If we use a 2-1 transformer it raises the impedance of the loudspeaker four times. Again, if the transformer ratio is 3-1 the speaker impedance is raised by nine times. Usually the ratio employed is about 20-1 when

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Adolph Zukor and the early movies

Arrival and Exit of the Nickelodeon

IN 1896, in the Hopkins Theatre, Chicago, Adolph Zukor had seen his first motion picture, a short flickering kissing scene between May Irwin and John Rice. The picture was used to empty the house after the vaudeville performance, to make room for the new crowd come to see the next show. At the time Zukor was impressed with the possibilities of Thomas Edison's invention, but awaited further development before determining his own participation.

It was on April 23, 1896, at Koster & Bial's Music Hall in Herald Square, New York, that Edison's *Vitascope* first introduced the "movies" to Broadway.

Later, about 1904, when he had committed himself to the amusement business, Zukor saw his first real movie with a plot and some sort of continuity. This picture was exhibited by Harry Davis in the basement of the old Grand Opera House in Pittsburgh.

The day of the Nickelodeon was dawning.

Any old vacant store, a sheet, a projection machine, a handful of folding chairs (mayhap rented from a convenient undertaker), or, perhaps, no seats at all—just standing room behind a railing—some plaster and tinsel and lights outside—a Nickelodeon. Uncomfortable, ill-ventilated, ugly.

Pictures of from 75 to 150 feet, flickering, admission 5 cents, "Those who have seen the performance please pass out."

But Zukor envisioned the possibilities. He and his partners, among them Marcus Loew, had several vaudeville theatres, in Brooklyn, in Newark and in New York. In these they began to show the novel, but not much liked movies.

Zukor became more and more convinced that in the motion picture, developed properly, lay the great amusement of the future. He was alone in his belief, the others looking upon the lowly flickering movie as a mere adjunct of the more favored and recognized vaudeville.

But Zukor saw every picture exhibited within his reach, he studied them and the public's reaction to them. He "went crazy" about the movies, in the opinions of his associates.

So much so that in 1908, Marcus Loew withdrew from his association with Zukor, returned his stock, and organized, independently, the Loew Consolidated Enterprises, offering vaudeville as the *pièce de résistance* and movies as the *demi tasse,* so to speak.

Zukor continued to study the motion picture and the public, from 1909 to 1912. He concluded that the destiny of the motion picture could be realized only when the pictures themselves were made worthy, in subject and execution, and when these finer pictures were shown in better theatres. The Nickelodeon had an unsavory reputation. Men sneaked into them covertly. To Zukor, envisioning the future of the motion picture, this was a challenge—to win for the movie its rightful place as a means of entertainment and instruction limitless in its possibilities.

He conceived, then, the project of capturing public recognition in one great overwhelming assault, risking all, to win or lose.

In that day the picture was regarded by professional actors and actresses as a mere novelty, unworthy of their art. Zukor saw that if he could induce some famous player to make a real picture, intelligently directed, and then exhibit this picture in a real theatre, he could wipe away the public's frown and create a smile of recognition and appreciation.

In 1912 Zukor organized the Famous Players Film Company, including among its shareholders the capable and respected Daniel Frohman, impelled by Zukor's sincerity and his previsioning belief in the motion picture.

Among the early pictures he had seen Zukor was impressed with those directed by Edwin S. Porter, then producing, for Rex, one one-thousand-foot reel per week. Porter stuck to the story, had a keen conception of continuity, and seemed to have reasoned the things he did. Soon Universal absorbed Rex, and Zukor invited Porter to join him in his undertaking to realize the artistic potentialities of the motion picture.

Once organized Zukor made ready to unfurl the Famous Players' banner emblazoned with the brightest star in all the galaxy of the time. Not just a famous player, but the most famous player of them all! the "Divine Sarah," herself.

Zukor sent Porter to France where Mme. Bernhardt had achieved a stage triumph in "Queen Elizabeth." He enlisted the assistance of Daniel Frohman.

Porter cabled finally that the picture could be produced and the American rights obtained for $35,000. *Thirty-five thousand dollars!* When six to eight thousand dollars was considered a gambler's, not a business man's, risk for a single picture!

Zukor cabled back "Go ahead." His associates in the Famous Players Film Company feared that his enthusiasm had swallowed his common sense.

So Zukor, serene in his faith, paid for that first feature film himself, out of his own pocket.

Then in November, 1912, when the first negative and print of "Queen Elizabeth" were received in America, Zukor further amazed his associates by insisting that the photoplay be shown in a theatre worthy of it. Whereupon he leased the Lyceum Theatre in New York City.

Instead of the flamboyant lithographs of the day, he employed an artist to make the first poster ever used to advertise a motion picture.

"Queen Elizabeth," the first dramatic story told in five reels of film, was received with acclaim. In one spontaneous burst of enthusiasm the public recognized the motion picture as a new art, possessing possibilities surpassing all prior conceptions.

Thomas Edison created the motion picture, Adolph Zukor had created the motion picture art.

Again, with Daniel Frohman's cooperation, he imparted his enthusiasm to James K. Hackett, who became the first great American actor to add his star to the Famous Players' banner. And "The Prisoner of Zenda" with Hackett in the leading role, was the first picture produced by the Famous Players Film Company.

The photoplay, as distinguished from the one-reel film, was an established fact, endowing a new era in the development of the budding motion picture industry.

During the year that followed, Zukor screened the most brilliant stars of the day—Mrs. Fiske, Lilly Langtry, Cyril Scott, Arnold Daly, Henrietta Crossman, Fritzi Scheff, Lenore Ulric, and many others.

In 1916, in order to expand his program and increase the facilities for the production of better and better pictures, the Famous Players Film Company and the Jesse L. Lasky Feature Play Company were combined to form the

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News for home movie makers

THE introduction of Cine-Kodak supersensitive panchromatic safety film is news to the world of home movie making. This remarkable new film puts an entirely new aspect on the subject of personal movies. The extreme speed and high degree of color sensitivity of supersensitive film batters down many of the photographic barriers of the past. Motion pictures can now be made of subjects that heretofore could not be photographed satisfactorily.

Pronounced sensitivity at the red end of the spectrum makes the emulsion of this film particularly efficient when exposed to rays of artificial light—especially light of incandescent lamps. As a result, the range of cine activities is signally extended.

With supersensitive panchromatic film, it is now possible—in fact, easy—for amateurs to photograph subjects indoors by the light of ordinary electric lights. No longer is it necessary to use expensive lighting equipment to obtain indoor movies.

To say the least, the imagination is taxed in attempting to conceive of all the numerous new channels of interesting movie making that are now open. As a striking example, a living-room can be quickly transformed into a temporary studio simply by placing two or more 100-watt bulbs in as many reading lamps. With the lens set at f.1.9, one is all ready for first-rate home movie portraits; closeups of the children, or numerous interesting subjects that do not require the source of illumination to be more than a few feet away.

Lighting effects that are different—and beautiful—can easily be obtained by placing additional lights at the sides of and behind the subject. One lighted bridge lamp set behind the subject produces a "back lighting" which gives a pleasing depth and roundness to the picture. See Fig. 1. It should be understood that the *direct* rays of artificial lights should not be allowed to enter the lens. Lighted floor lamps and table lamps can be included in the picture, and will not cause fog or halation if the bulbs do not show through or under the shades. It must be remembered, however, that brilliant pictures can only be made when there are additional lights (out of range of the camera) for direct illumination.

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Supersensitive panchromatic safety film for 16 mm. cameras announced.

By increasing the number of electric bulbs, the camera can be placed farther from the subject thereby increasing the scope of the picture.

An exposure table for Cine-Kodak supersensitive Panchromatic film when it is exposed under artificial light conditions is given:

EXPOSURES TABLE FOR CINE-KODAK SUPER-SENSITIVE PANCHROMATIC FILM

These exposures are for the Cine-Kodak operated at normal speed. Halve the illumination at *half-speed.*

Distance from Lamps to Subject	Diaphragm Opening	Total Wattage of Lamps
2 feet	f.1.9	200
2 "	f.2.8	300
2 "	f.3.5	400
3 "	f.1.9	300
3 "	f.2.8	450
3 "	f.3.5	600
5 "	f.1.9	600
7 "	f.1.9	800
9 "	f.1.9	1200

Best lighting is obtained by arranging the lamps on each side of the camera, so that both sides of the subject are illuminated. It is advisable to place the lights at different distances from the subject. For example, the table gives an exposure with the lamps 3 feet from the subject; the lamps can be placed 2½ and 3½ feet from the subject. The camera must be in a position so that the lights used for direct illumination will not show in the finder.

Fig. 1. In this picture the diaphragm opening was f.1.9, and six 100-watt bulbs were supplemented with two 60-watt bulbs placed in a reading lamp.

One of the largest fields of picture activities opened by the new "pan" film is that of indoor sports—basketball games played in well lighted gymnasiums, indoor track events. Other athletic events taking place on well lighted platforms can be easily photographed when stop f.1.9 is used. If the illumination is exceptionally good, even smaller lens openings can be employed.

The increased range of picture taking provided by the new film actually embraces night scenes on brilliantly lighted streets, or theatre districts in large cities. For pictures of this kind the camera must be fitted with an f.1.9 lens and the largest stop (f.1.9) must be used. Best results will be obtained after a rain. The glazed surfaces of the street and the sidewalks will then reflect the rays of the hundreds of lights, giving added illumination and unusual effects. If the lights are very brilliant, the camera can be used at normal speed. Half-speed gives twice the exposure and generally produces more brilliant pictures. It should be kept in mind, however, that the action of moving vehicles and people walking on the sidewalks will be twice as fast. That is not so objectionable in the case of automobiles or street cars, because they then only appear to move more rapidly, but the action of people walking will be jerky.

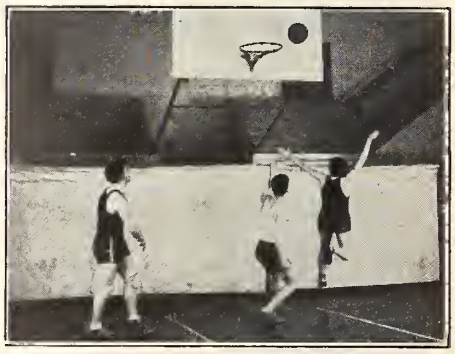

Fig. 2. In well lighted indoor courts, excellent pictures can be made on supersensitive panchromatic film with the lens opening of f.1.9.

Fireworks, flood-lighted buildings, camp fire scenes, are all now within the scope of night movie making.

The remarkable qualities of the new film are valuable for daylight photography as well as for pictures at night. The increased light-sensitivity of the film is not confined altogether to the red end of the spectrum. It is nearly twice as fast to blue and ultra-violet light as regular panchromatic film, permitting successful pictures to be made under very adverse weather conditions. Unique shots can be made during a downpour of rain with supersensitive film, and the cine camera becomes an efficient instrument during the early hours of the morning or in the weak light of the afternoon.

Sound systems in public schools

By Ralph P. Glover

THE public school systems of this country and elsewhere constitute a vast potential market for sound equipment that is still relatively unexplored. However, many manufacturers who confidently expected large orders for equipment from the schools have been sadly disappointed in the volume of this business. The fact that all public institutions are practising rigid economies due to existing and expected reduction in the rate of tax receipts, is of course sufficient reason for curtailment of expenditures for expansion, but there is an additional impasse which must be analyzed from the educator's point of view.

Those familiar with the flexibility and multitudinous uses of sound service may think it strange that considerable broad selling remains to be done in this field. This is nevertheless true in spite of the enthusiasm of prominent educators all over the country for what promises to be a new method of instruction. And naturally, the selling of principles must precede the selling of particular brands of equipment.

The educator almost invariably refers to *sound instruction* as "radio" instruction. This is the natural mental association of the loudspeaker with the radio receiver, although the significance of the microphone and phonograph pickup may be known. Additional justification for this nomenclature comes from the logical plan to utilize radio broadcasts as the primary source of this type of educational material. This is the phase of sound education that appears to be uppermost in the minds of school authorities at the present writing. We find school boards, professional educational societies, colleges and government agencies working on two main problems; first, the policies involved in the actual broadcasting, such as financing, securing appropriate speakers and material, and details which must be worked out in cooperation with the stations and networks; second, the development of a suitable new technique of teaching in the classroom with an invisible speaker. To summarize: Educators are studying formal instruction by means of radio broadcasting. They apparently feel that *sound instruction as a principle* must stand or fall according to what can be done with broadcasting and their inquiries are pointed in this direction. The local microphone and phonograph pickup are viewed simply as useful accessories in a majority of cases.

If these views are as generally held in the educational field as we believe them to be, then it is not strange that equipment salesmen rarely reach the dotted line stage. The large mass of educators are not yet ready to lend an ear to descriptions of particular makes of sound equipment. Of course, a great many schools have already purchased central receiving and distributing equipment, and where reliable technical guidance has been sought, and the situation has been thoroughly studied, followed by careful installation of suitable reliable equipment, results have been most satisfactory. Other schools have actually been victimized by perhaps well meaning, but obviously incompetent or selfish vendors, and it is certain that this has reacted to the disadvantage of the sound industry in general. The impasse can be broken down most rapidly if the problems involved in sound systems in public schools are approached with public service and cooperation foremost in mind, relegating thoughts of profits, discounts and commissions to the background for the time being.

Material From Radio Broadcast Sources

While it is certainly wise and desirable to ultimately divorce educational radio programs from commercial sponsorship, there still remain many existing programs of various types which appear well suitable to school use. Without going into detail, these include outstanding musical, dramatic and many sustaining program features, eye-witness descriptions of important national and world events and addresses by prominent individuals. There are a number of purely educational programs on the air and others are about to be inaugurated. Undoubtedly not representing the ultimate in desirable educational material, we believe that those schools which have access to these programs at the present time are enabled to make good and beneficial use of them.

On the other hand, the justification for sound equipment in public schools should not be thought of as resting entirely on the utility of radio programs, and this idea, where held by educators, should be dispelled promptly, not primarily for the sake of accelerating sales and profits, but to insure that planning covers the ultimate uses to which this equipment is sure to be put. The future benefits of a clear understanding of the whole problem to both schools and industry, are rather obvious.

There are points that the sound equipment industry has failed to emphasize sufficiently in dealing with the schools. Briefly, they seem to be:

(1) Sound equipment has many administrative and executive uses, not involved in actual teaching, but extremely useful in communicating with groups of individuals in schools and elsewhere. These require no enumeration—it is simply the case of the telephone extended within earshot and audibility of a group or number of groups with evident advantage and convenience.

(2) The microphone itself is becoming a familiar sight in broadcasting, sound pictures, at meetings, public affairs and many group functions. Individuals are being called upon to face the microphone with increasing frequency. It is probable that the technique of public speaking in the future will be a microphone technique, requiring a knowledge of the correct positioning, delivery and enunciation for the most effective use of the instrument, and such instruction may well form a part of the school curriculum.

(3) Complete sound equipment makes it possible for students to take part in original programs and entertainments, presented before the whole or any selected portion of the school, without the necessity for any student leaving the home classroom.

(4) Complete sound equipment offers valuable assistance to special teachers in music, physical education, etc. It enables them to duplicate their efforts, to work more rapidly, thoroughly, and economically, and widens the possible scope of their activities. In many applications, no new teaching technique is involved.

(5) The details of the equipment

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Sound equipment manufacturers, architects and contracting company engineers should study the school market. There are two services involved: the reception of external radio broadcast instructional matter; and, the internal use of sound amplifying systems

itself are educational, particularly for science and vocational classwork.

A properly designed and carefully installed sound installation offers the advantages enumerated. Whatever the situation may be, the equipment should be capable of expansion and adaptability to a wide and complete service of sound distribution.

Preliminary Plans

The preliminary preparations for sound facilities in new schools have an important bearing on the amount and type of equipment that can be sold. Many new school buildings are being "wired for radio," as the phrase goes, since the expense of conduits and cable is a negligible item compared with the total building cost. Unfortunately, many architects and electrical contractors are totally unfamiliar with the special requirements and desirable features of audio-frequency transmission systems. Their work is characterized, usually, by lack of provision of sufficient radial distribution lines from the control point, and conduit sizes which are too small to accommodate shielded cable. Conduit facilities for out-of-doors speakers and microphones, so desirable for directed play and games, and microphone extension lines within the building are seldom if ever to be found. This, of course, imposes immediate limitations on the scope of the sound system which can be installed without extra wiring, and adversely affects the likelihood of present and future sales of "extras," such as microphones and loudspeakers. The moral is evident—sound equipment manufacturers and sound engineers must encourage school authorities to specify complete and proper wiring details for all new buildings. Both parties will thereby profit in the long run.

Just what amount and type of equipment should be included in the first purchase, is a field problem that must be solved on the job. It depends on the policy governing sound installations and on the amount and source of the available funds. In new schools, the initial equipment purchase may be delayed indefinitely. Where public funds are limited, as they often are, financing may be undertaken by graduating classes, parent-teachers organizations or by philanthropic individuals.

Here again, is an opportunity for unselfish public service on the part of the sound equipment industry, for it is not difficult to sell profitable but *quite unsuitable* equipment to such unofficial organizations or individuals, particularly when the school board has adopted a "hands off" policy for these cases. In one incident which came to the writer's attention, a thoroughly reputable maker of so-called "standard equipment," either through indifference or gross selfishness, sold an expensive multiple-channel radio installation to a school through a graduating class. Of course, the equipment itself was the "best" obtainable and beyond reproach in that respect, but it is doubtful whether a plant of this type will *ever* find wide application in the schools; as an initial purchase, it was certainly an ill-considered luxury that would have been quite in order in the case of an apartment house or hotel.

A genuine public service would have been performed if this considerable amount of money had been directed toward a more balanced sound installation, including microphone and phonograph facilities and a wider extension of the now limited number of sound outlets. Any ethical technical man can supply appropriate remarks which cannot be included here.

Although it is manifestly difficult to generalize, a few general principles appear to have universal application in the selection of suitable school installations, whether in old or new buildings, and regardless of the source of funds.

(1) The equipment should be capable of high-quality sound reproduction.

(2) For obvious economic reasons, the equipment should be of a type that can be expanded or modified as the need arises. This requires the least initial outlay and only moderate expense later on. Obsolescence can be made an unimportant factor. Unit equipment, rack-mounted seems to offer attractive advantages.

(3) The equipment should be capable of complete operation by non-technical personnel without undue sacrifice of flexibility.

(4) The purchaser should be protected against the possibility of subsequent suits alleging patent infringement.

All of the above points apply with more or less force in many cases other than school sound installations, but are particularly important in this respect.

It is expected that eventually the technical supervision of such work will be delegated to qualified experts representing school authorities. This step should be welcomed by the sound equipment industry, for it will promote careful planning in advance of immediate requirements and eliminate inferior products from the field of acting competition.

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OUTPUT MATCHING TO LOUDSPEAKER

(*Concluded from page* 16)

a single output tube and single loudspeaker are being considered. A transformer ratio of this latter figure raises the effective impedance of the loudspeaker 400 times.

The choice of a coupling transformer is now relatively simple. First of all, we find the impedance of the output tube and then that of the loudspeaker unit at a frequency of approximately 256 cycles per second. We now double the former impedance and if necessary make modification of both impedance values depending on the employment of multiple output tubes and loudspeakers. When this has been done, we are left with two quantities—A, the doubled effective impedance of the output tube or tubes, and B, the effective impedance of the loudspeaker or speakers, placed either in series or parallel as the case may be. In all probability the latter value will be smaller and when divided into the other approximates a numeral. Whatever this may be, its square root is extracted and proportioned against 1 gives the transformer ratio required. Thus, if the impedance of the loudspeaker or speakers goes into the effective impedance of the output tubes 3.6 times we may take this as 4 and extracting the square root we find that the ratio of the step-down transformer is 2-1.

Putting this in a nutshell we may say that: (the impedance of loudspeaker at 256 cycles per second) x (Transformer ratio)^2=2 x (impedance of output tube). In this due allowance must, of course, be made for multiple tubes and loudspeakers as previously described.

The case of the tapped choke is precisely similar to that of a transformer —in fact a tapped choke when used as a coupling between output tubes and loudspeakers acts merely as an auto-transformer and possesses in some ways the limitations of this type of electrical device. Thus a center tapped choke is equivalent to a transformer having a ratio of 2-1 and if the tapping occurs at one-third of the winding the equivalent transformer ratio is 3-1 and so on.

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HAND-COLORING OF MOTION PICTURE FILM

A PAPER on the above subject presented at the recent S. M. P. E. meeting in Hollywood by Gustav Brock deals with the advantages of selective hand coloring, as distinguished from more or less complete coloring which is not yet perfected, and covers shortly the use of hand-coloring in educational, commercial and theatrical pictures. Finally, a description is given of the equipment used for hand-coloring.

Measuring screen brightness

THE appreciation of the vital importance of the proper degree of screen illumination renders the accompanying chart of valuable assistance to the painstaking projectionist, who has substituted mathematical calculation for rule of thumb methods in solving his problems.

It is contributed by Hall and Connolly, Inc., as an aid in ascertaining with a more than fair degree of accuracy, the degree of brightness which may be obtained on various sizes of screen, with any one of the standard projection lamps of modern design.

The chart also pictures the improvement in projection lamp optics and the progress made towards better screen illumination by the above named company in collaboration with optical manufacturing concerns.

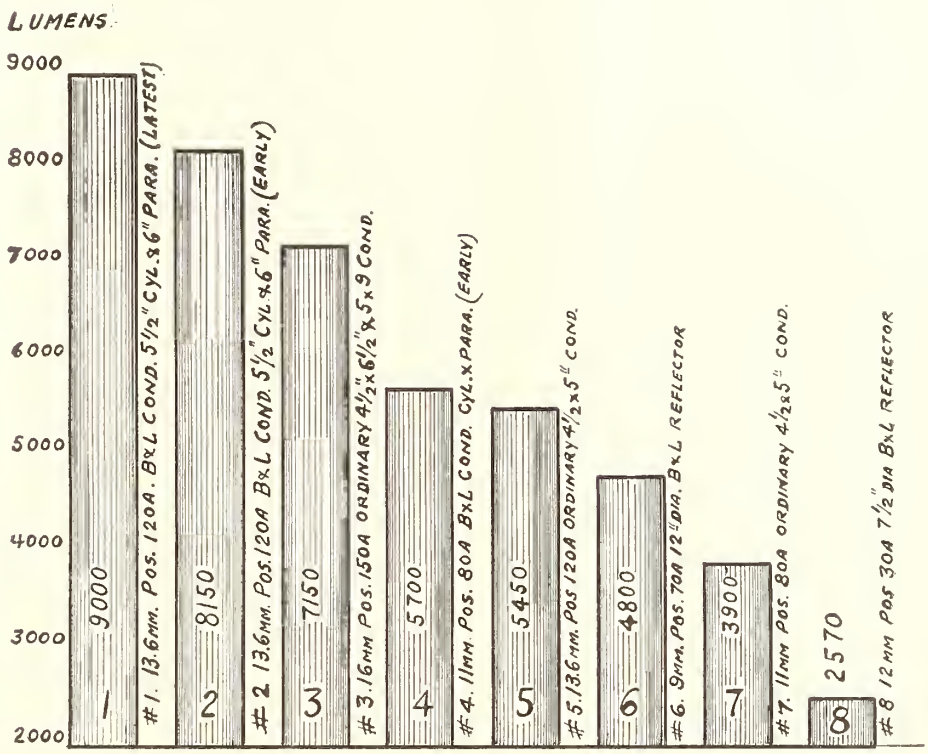
The chart is based on international Lumens, a measure of the quantity of light. Lumens being the product of intensity in foot-candles multiplied by the area of the screen in square feet, the Lumens, as indicated on the chart, for each outfit specified, divided by the square-foot area of any individual screen, will give the foot-candles brightness of that screen.

The chart was based on data obtained from 240 tests, made at the Hall and Connolly laboratory under uniform and technically correct operating methods during which a mean of the readings was taken and plotted, with special care to avoid abnormal peaks.

Particular care was taken to tabulate only such results as might reasonably be duplicated in actual theatre practice.

With this chart anyone can determine the intensity of illumination on any given size of screen, with any of the various types of lamps and optical "set ups"—from the 30 ampere low intensity reflector lamp, to the 120 ampere high intensity outfit equipped with latest large aspheric condensers.

Condensers indicated on the chart as "latest" are the improved types, now furnished as standard for all present HC lamps.



Showing relative light output for various types condensers and reflectors. Note: All tests were run under uniform operating conditions—light projected through Cinephor Series II objective lens.

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A SOUND FILM RE-RECORDING MACHINE

A paper on the above subject was presented by J. J. Kuhn, at the S. M. P. E. meeting in Hollywood, recently.

In sound picture production, the process of making the release print negative for sound requires the reproduction of the existing sound record in order that it may be recorded in proper continuity and corrected for volume level. The machine used for this purpose is called "Re-Recording Machine."

This paper describes a new re-recording machine recently made available which is suitable for use in studios using either the variable density or variable area method of sound recording. The machine described employs a novel type of film aperture and a new method of focusing the sound lamp. To insure uniformity of film movement and to eliminate unwanted noises in the re-recording process, workmanship must be of the highest order. Some of the requirements and testing methods employed in the manufacture of the machine are described.

Dont's for Theatre Projectionists

By C. B. Gordon-Sale

Here Are 58 "Don'ts" Which, If Properly Observed, Will Prevent Expensive Interruptions to Service

SEVERAL of the other mechanical trades have from time to time published a series of dont's for members of their professions. Thus the writer ventures to submit the following as applying to sound projection.

1. Don't switch quickly on to "Plate" even if tubes seem to stand it.
2. Don't interchange rectifier and amplifier tubes.
3. Don't use a "recovered" photocell.
4. Don't test out horn type receiver without horns.
5. Don't assume the stage horns are O.K. when the monitor is working.
6. Don't close the motor switch before pulling round for one-half turntable revolution when on disc.
7. Don't wear a long trailing overall.
8. Don't clean contacts with carbon tetrachloride—it may eventually corrode them.
9. Don't forget to turn down the exciter lamps after a show—the batteries will probably be recharged between times.
10. Don't fix lamps within 4 feet of sound unit.
11. Don't return an exciter lamp until it burns out. Renew when it starts blackening or the filament sags slightly.
12. Don't alter the position of the lens tube in the sound unit.
13. Don't expect pre-focussed separate exciter lamps to align perfectly when they are shot home. Readjust after the reel is cleared.
14. Don't forget a little graphite grease often stops a noisy resistance.
15. Don't forget that any loose metal object near the PEC compartment may introduce crackle.
16. Don't, in W.E. equipment, have the PEC coil too tight or too slack—both conditions are bad.
17. Don't let oil accumulate in the PEC compartment. Swab out with rags and be more sparing with the oil can.
18. Don't try to alter the bill without unlocking the clamp in a U-Base.
19. Don't let flexible couplings run out of true even if they will stand it.
20. Don't cuss the second when he's late with the dowser. Fit a chain device of some sort and let one man do the job.
21. Don't run with a warped disc. Use the standby or, if pressed, lay the faulty one flat in the sun or in a hot room which should cure it.
22. Don't try to undo a "buck" hexagon grub screw with the end of a file. Keep the special wrench in your pocket.
23. Don't forget that a single universal joint can *never* turn easily. Two will if the angles with the main shafts are equal.
24. Don't forget flexible shafts sometimes require lubrication.
25. Don't tie a flexible shaft in knots. Give it a fair chance.
26. Don't cut off any wire. Unsolder it—you may be glad of a spare inch later on.
27. Don't bare wire ends with cutting pliers or a pocket knife. Pull off the rubber with needle nosed pliers which will not damage the wire or scrape off the tin.
28. Don't say resin flux is too slow and use spirit.
29. Don't examine storage cells with a lighted match—your eyes are valuable.
30. Don't forget to clean the soldering iron after you have used it for greasing accumulator lugs.
31. Don't re-mark a projector without checking the turntable if your machines are U-Base type.
32. Don't get the picture right and let the bed go hang. Level the bed and pack the head.
33. Don't grouse about surface noise when there is machine noise.
34. Don't use cheap needles or try experiments with "permanents." "Loud tones" are best.
35. Don't get oil on a disc.
36. Don't clamp needles too tight or you may throw the pickup out of adjustment.
37. Don't forget that reproducer "drift" is almost as important as correct tracking.
38. Don't blame recording for flutter before you have checked shaft alignment and damping arrangements.
39. Don't omit to test the reed type pickups for equal tuning. Tap the needle both sides and check the "plop" for volume and pitch.
40. Don't forget to replace burned out pilot lamps. Some day you may have need of them.
41. Don't expect an amplifier to be dead as soon as the mains are pulled. Condensers remain charged and a 1,000 volt kick is painful.
42. Don't test for a started condenser with a 6 volt buzzer. It is useless nine times out of ten.
43. Don't omit to correct output levels when replacing a PEC.
44. Don't smack a dud PEC near water—some types explode.
45. Don't search for echoes in the auditorium with the ports open.
46. Don't forget that heavy drapes near the screen will cut off the top and leave the boom.
47. Don't flare a buzzer near the sound unit or you may get pickup of an unwanted nature.
48. Don't tighten motor brushes to stop sticking before examining the commutator for dirt.
49. Don't forget electric motors generally want end float. Set couplings to allow for this.
50. Don't test tube emissions before everything is properly warmed up.
51. Don't think a reduced filament current is economy.
52. Don't forget too low value cartridge fuses sometimes have a higher resistance which upsets meter readings.
53. Don't forget if a grounded wire breaks you can always pick up from earth.
54. Don't store "B" batteries. They deteriorate with time whether they are used or not.
55. Don't forget an oily lens or PEC window cuts off top.
56. Don't use the scratch filter to the sacrifice of clarity.
57. Don't forget that condensers may be shopped out for the time being.
58. Don't forget there is no such thing as a cheap, dependable resistor.

Portable 16mm. camera used for slow action pictures

Photo by Bell & Howell

Making slow-motion movies of a player's golf stroke. Joe Novak with the camera.

MANY golfers now-a-days are improving their game by the motion-picture method. Even Bobby Jones, we are told, has for some time been accustomed to have movies made of his strokes for his personal use, and he studies the pictures in order to catch possible imperfections. When Bobby was in England last year the Prince of Wales used his own Filmo movie camera to "shoot" the Georgian as he played.

"The point is that a new method of teaching and learning the ancient and honorable game of golf has arrived—the movie method," says a writer in June *Filmo Topics* magazine. "This new method, besides winning the commendation of thousands of players, has been unqualifiedly endorsed by the Professional Golfers' Association of America, composed of the best golf instructors in this country. The movie method aids the tyro and more advanced player as well."

The writer continues: "When golf is taught via movies the motion picture camera is used to record every detail of your play in slow motion. The pictures are then studied and suggestions made to correct errors and to effect improvements. The slow-motion feature makes it possible to follow every movement. Many times you will find that you were not playing the way you thought you were. The quickness of your play deceives the human eye but it cannot elude the eye of the camera.

"You can have pictures taken of your game and then study the plays yourself, or you can have your pro 'diagnose' the case and advise what to do. Many pros are now equipped with movie cameras to take pictures of their pupils in action. They throw these pictures on the screen and appraise the plays. Every single movement can be subjected to scrutiny, and necessary curative methods prescribed. Progress in your game can be watched and traced in subsequent pictures."

As a sort of second-line auxiliary in the golf-by-movies idea, slow-motion film studies of golf stars can be projected on a movie screen and studied by the aspirant who wants to see how the big ones do it. There is available a fine selection of 16 mm. golf films, including several "talkies."

The Professional Golfers' Association, quite generally known as the P. G. A., recently sponsored the making of super-slow movies of Jones, Joyce Wethered, and Harry Vardon. These pictures are rendering a tremendous service in arousing interest in movie golf instruction. Following a showing of these movies in Chicago, an Associated Press report of the pictures was carried in many newspapers throughout the country. Arthur Brisbane in his newspaper column "To-Day" has raised his voice to comment upon golf movies and their objectives, and Alex Pirie, the dean of the pros, is of the opinion that motion pictures will be of extraordinary benefit in teaching.

Value in Instruction

Mr. Pirie has been quoted as saying that previous instruction has been all wrong. "To the contrary," says Herb Graffis in *Golfdom,* "he is of the opinion that much of it is far advanced, and to make the advance general, the P. G. A. pictures were shot. Thoroughly analyzed by competent men, the pro pictures, it is hoped, will eliminate a great deal of debate about what is proper instruction. A great simplification of golf instruction is one of the main objectives of the pictures." One noted pro, we might add, is of the opinion that golf movies will show that all golf instruction can be reduced to emphasis on three fundamental points.

Concrete glimpses of the P. G. A. pictures are afforded by Mr. Brisbane in his "To-Day" comment. "Slow-motion 'movies' of the great Bobby Jones and the beautiful Joyce Wethered in action show that these great golfers do not 'break their wrists on the back swing' until very late in the swing," he says. "And Jones, the Great, hesitates at the top of his swing, shifts his body and gets planted before he brings the clubhead down."

For making golf movies the small, portable, and relatively inexpensive 16 mm. camera will fill every ordinary requirement, provided care is taken to select an instrument of reliable make, constructed to film pictures at the rate of 64 or 128 exposures per second, which are the speeds necessary for making satisfactory slow-motion golf pictures.

George Sargent, the noted pro of the Scioto Country Club, Columbus, Ohio, who has been a prime factor in the motion-picture golf instruction movement, uses a Filmo amateur movie camera in his golf work, as does also Al Lesperance, the well-known pro of the Westmoreland Club, in suburban Chicago. So do Joe Novak and other leading professional instructors—and Bobby Jones has done so for some time.

Many a player has cut his golf score substantially by the movie method and is still shaving it down.

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ADOLPH ZUKOR AND THE EARLY MOVIES

(*Concluded from page* 17)

Famous Players-Lasky Corporation. Later that year, the Oliver Morosco Photoplay Company, Pallas Pictures of Bosworth, Inc., and, early in 1917, the Paramount Pictures Corporation, were absorbed by the Famous Players-Lasky Corporation.

Though the Paramount Pictures Corporation was dissolved as a separate corporate entity, the appropriate name, Paramount, was retained and applied to the productions of the Famous Players-Lacky Corporation.—*From a story prepared by Esten Bolling for The Carrier Engineering Corpn.*

The use of positive film in sound recording

By Charles Felstead*

CONTRARY to general opinion, the film used in film sound recording machines is not of the same type as that employed in motion picture cameras. Negative film stock is used in the cameras for photographing pictures. After exposure this negatime film is developed and printed on positive film stock, which is likewise developed after being exposed to the printing light. But in the film recording machines employed for recording sound in a track near the edge of a strip of motion picture film, positive film is used. There are two reasons for this: positive film has less "grain" than negative film, and also it is less expensive. A positive print is made from the sound track in the same manner that a positive print is made from the negative picture film. Paradoxically, to differentiate between the positive film stock and the positive print, the positive film that is exposed in the film recording machines is called the "sound negative," because the final positive print is printed from it.

"Grain"

A piece of film that is exposed and developed has on it an image of the objects which reflected light against it and exposed it; but that image is not smooth and homogeneous; it is composed of a multitude of minute specks that cannot be seen individually under even the most powerful magnifying glass. These specks constitute what is known as the "grain" in film. Although they are not large enough in themselves to cause trouble, the specks have the odd property of so reflecting light that they appear to collect in groups and form larger specks. These specks are crystals of solid silver formed on the celluloid film base, and as such they are covered with a multitude of little reflecting faces. or facets.

A light shining on the crystals is reflected from one to another, back and forth, and cannot get through the film at that point because of the reflection and re-reflection of the light beam. This multiplies the apparent size of each speck many fold, and produces the optical illusion of a much larger black spot when light is thus directed through the film. The effect is really one form of what is known as "hallation," and is termed "diffusion hallation."

As far as possible, the grain of the developed and fixed emulsion should be maintained extremely fine—or rather, the reflecting quality of the crystal facets should be reduced to the minimal amount by treating them chemically in the fixing solution to dull them—in order that the grain will not be evident in the film. Naturally, the more homogeneous and smooth the image on the film, which is to say the finer the grain, the better the image will be.

This is particularly true of a sound track of the variable density type, because in it the exposure lines representing the high frequency sounds are very narrow and very close together. If these lines are not smoothly and evenly recorded by the film, the reproduced sound will not be a faithful copy of the sound that was recorded, because the light beam used in the reproduction will not be cleanly interrupted by the striations in the sound track. If the grain is coarse enough, the reproduced sound may even have noise in it from that source. Positive film stock is not used in motion picture cameras because it is treated with a "slow" emulsion, made up mostly of silver chloride crystals with silver bromide crystals sometimes added carried in suspension in a solution of gelatine, which means that it requires a much greater exposure than the faster negative film emulsions, in which silver bromide crystals are used entirely in place of the silver chloride. From one to ten per cent of silver iodide is often included in these emulsions.

This greater exposure can be accomplished by slowing down the rate of speed at which the film moves through the camera or recording machine, or by increasing the brightness of the light that causes the exposure of the film. The result in either case is practically the same.

Since the speed of movement of the film is kept at precisely ninety feet a minute in the cameras and recording machines in sound picture work, this speeding up is not possible. But greater exposure of the film is easily accomplished in a film recording machine by increasing the intensity of the light source producing the exposure. However, it is not practicable to increase the light causing the exposure of the film in motion picture cameras because the illumination used on sets is already as intense as convenience and economy will permit.

* *Sound Engineer, Universal Pictures Corporation.*

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An Explanation of What is Meant by "Grain" in Film, and Its Effects.

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SPLIT MAT SHOTS IN SOUND RECORDING

A paper on the above subject presented by L. E. Clark, at the recent S. M. P. E. meeting at Hollywood, discusses the technical problems which arise in motion picture studios and which must be solved quickly, cheaply and with the utmost simplicity. All engineering work must be done with an eye to production. As a result, the methods and equipment developed in the studios are frequently peculiar and highly unorthodox when viewed alongside scientific developments produced in the laboratory. The paper describes the problems which arose in one particular studio, as a result of the use of double exposure photography, and the methods, more practical than scientific, which were developed to meet these needs.

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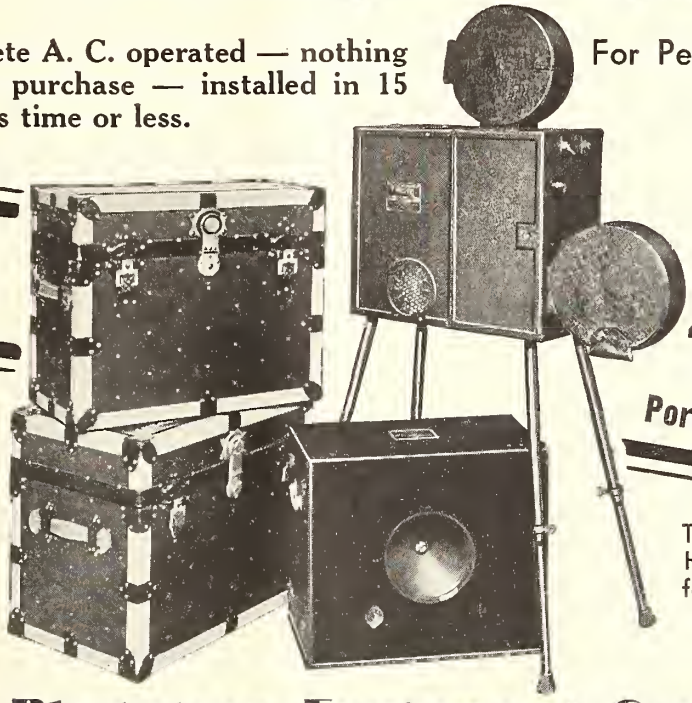

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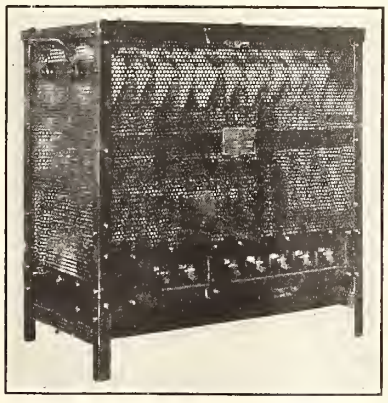

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PERFECTION **RHEOSTATS**

New Developments and News of the Industry

PHOTOTONE PROJECTOR

The Phototone projector which is manufactured by the Phototone Equipment Corporation, 309 N. Illinois Street, Indianapolis, Ind., is a compact and extremely sturdy portable talking picture unit. It is designed for sound on film recording and is capable of reproducing both variable density and variable width methods of recording.

The equipment is for use with 110 volt 50 to 60 cycle a.c. without the use of motor converters. The amplifier unit has incorporated in it a rectifier using 281 type tubes in a full wave rectification circuit. The last stage of amplification is push-pull with 250 type tubes.

The projector head is so designed that the wear on films is reduced to a minimum. This enables commercial companies which use talking films to carry sales messages, to use their films repeatedly with little wear.

The operation is simplified so that any amateur can operate the projector. It is also practical for schools, churches and hotels where there is not permanent installation.

The equipment weighs only 195 pounds not including the weight of the trunks. This weight includes projector, amplifier, screen and necessary attachments. The trunks bring the weight up to 235 lbs. which is light for mechanically strong equipment.

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A NEW BUG ELIMINATOR

Bugs, insects, mosquitoes, are the bane of all theatres.

During the hot summer months, these pests swarm about lamps, annoying patrons, and in general spoiling the effect of refreshment and rest that should accompany a good show. Consequently, the news is most welcome that a simple and inexpensive method of eliminating such pests has been discovered.

Reynolds Electric Company have developed a special natural colored glass hood for placing over white lamps. The Reco color hoods in green, canary, or amber colors, when placed over white lamps, positively repel insects, bugs, etc.

These hoods are made in sizes to fit over white lamps from 10 to 500 w. lamps. For floodlights, etc., Reco color plates are available.

Hoods are inexpensive and further information will be given by writing direct to the manufacturer, Reynolds Electric Company, 2650 W. Congress Street, Chicago, Ill.

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NEW LAMP FOR PHOTOGRAPHY

Herbert Conord, president of Blue Seal Products Corpn., 260 Wyckoff Street, Brooklyn, N. Y., announces that his company has ready for delivery a new lamp for shooting both still and silent pictures indoors, and outdoors at night. This lamp is known as Blue Seal Photo Sun Arc Lamp. It gives constant, flickerless light.

IMPROVED PICKUP FOR ELECTRICAL TRANSCRIPTIONS

For the faithful rendition of electrical transcriptions at a minimum investment the Stevens Manufacturing Corporation of Newark, N. J., has developed an ingenious turntable and pickup. This equipment is suitable for broadcasting, theatre, auditorium, club, demonstration or other purposes where the superior qualities of 16-inch, 33-1/3 r.p.m. recordings are sought.

The new Stevens product comprises an 18-inch turntable, a precision electromagnetic pickup with balanced tone arm, and necessary controls, mounted in a heavy wooden case with cover and handles for portability. A companion stand is provided if desired. Instead of an elaborate system of driving shafts and gears, the turntable is driven by a silent and constant-speed motor through a friction drive applied directly to the inner face of the turntable rim. The motor is mounted with a pivotal spring tension so that the friction

drive makes positive contact at all times. An automatic governor maintains constant motor speed despite wide fluctuations in line voltage.

In order to prevent a nautical roll or wobble, which is a common cause of tone distortion in the handling of large records, the turntable is mounted on a ball thrust shaft sunk in a deep well. Due to the fact that there is no drive or strain of any kind on the shaft, the turntable cannot become wobbly or go off center. The turntable is so accurately balanced and mounted on its thrust ball bearings that it will rotate for a long period of time after the electric power is turned off.

The Stevens electrical transcription pickup is employed in a steadily increasing number of broadcasting stations, as well as for theatre, auditorium, club, demonstration and other uses.

SERVICE-ON-SOUND MOVES

The Service-On-Sound Corporation have moved their consolidated offices with J. A. Tannenbaum, Inc., into their new headquarters, in Suites 607 and 609 at 1600 Broadway, New York. The S.O.S. Corp. expects to set up a permanent display of both portable and stationary sound and projection equipment. In addition, there are spacious sales rooms, in which out-of-town buyers can view the latest in cinema and theatre supplies.

The S.O.S. Corp. is known as the "Mail order house of the industry," and its connections and outlets are far-flung throughout the world.

J. A. Tannenbaum, Inc., have been closely associated with the S. O. S. Corp. for several years.

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CINEGLOW

The U. S. Navy has purchased a Cineglow Portable Land System with the new Akeley Audio Camera for use of the Recruiting Bureau.

Dr. Paul L. Hoefler, famous for his "Africa Speaks," has also bought a Cineglow. He plans another trip to Asia.

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MOTOR SPEED REGULATORS

Ward Leonard speed regulators are designed for use with constant torque and variable torque a-c. and d-c. fractional horsepower motors. They are built to conform with N.E.M.A. Classifications Numbers 93 and 95 and are listed as standard apparatus by Underwriters' Laboratories. The Underwriters' listing is given under "Industrial Control Equipment—Motor Controllers—Manual" as number 1101. This number appears as the first four digits of the identifying number on the name plate.

These regulators can be furnished for use with series-wound a-c. motors. When so used, the rheostat usually has no "off" point or the full speed position is located next to the "off" point to assure full torque at starting.

These regulators are furnished with a moulded knob designed to indicate the position of the contact arm.

As the current capacity and resistance required for proper control of a-c. fans or motors varies widely, no rheostats are listed for this service, but prices and information will be furnished on request.

These regulators are manufactured by the Ward Leonard Electric Company, Mount Vernon, N. Y.

▲

S.M.P.E. MEMBERS VOTE ON NEW YORK AND DETROIT FOR FALL MEETING

Ballots have been sent to members of the Society of Motion Picture Engineers for a vote on the location of the Fall meeting. The board of governors have selected New York and Detroit for the choice of cities and the tentative date for the Fall meeting has been set for October 19 to 22 inclusive.

THE Group Subscription Plan for PROJECTION ENGINEERING enables a group of engineers, executives, projectionists or technicians to subscribe at one-half the yearly rate.

The regular individual rate is $2.00 a year. In groups of 4 or more the subscription rate is $1.00 a year. (In foreign countries $2.00.)

The engineering departments of hundreds of manufacturers in the projection and allied industries and scores of the M. P. M. O. U. locals have used this Group Plan extensively, in renewing their subscriptions to PROJECTION ENGINEERING.

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A live-wire cameraman can make BIG MONEY recording local events, tieing up merchant-theatre campaigns, recording Industrial, Advertising, and Political campaigns, or Educational shorts. In Grantwood, New Jersey, the Royal Studios, Inc., is installing a double studio type Cineglow System and the new management plans a series of feature productions. Similarly recordings made in the Atlas Soundfilm Studios of New York are now enjoying nation-wide release.

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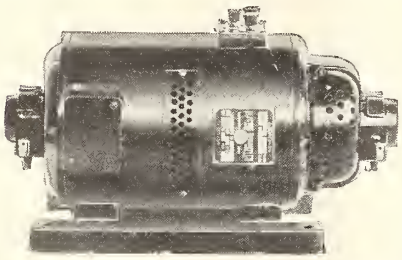
MOTOR GENERATORS FOR REPLACING STORAGE BATTERIES IN THEATRES

Motor-generators for replacing storage batteries in theatres have been developed by the Electric Specialty Company of Stamford, Conn. These machines supply low voltage direct current for the fields of loudspeakers and for the exciter lamps of the sound equipment. They are very carefully designed so that they do not cause any objectionable background hum in the loudspeakers. A simple filter system is used when they supply power to the exciter lamps, but filters are not used with the horn fields. The machines are furnished complete with filters, when required, and they may be readily connected in place of the storage batteries.



These machines are of exceptionally rugged construction and are mechanically designed for the least possible amount of attention and maintenance expense. Wool packed sleeve bearings are used, which require no attention except very infrequent lubrication and which run very quietly. The machines are semi-enclosed, all live parts and rotating members being completely protected. Terminal boxes are provided for conduit connection.

These motor-generators provide the most reliable source of power obtainable and are more economical in the long run than other forms of power supply apparatus.

▲

POWER AMPLIFIER

Model GA-80 manufactured by the General Amplifier Co., Cambridge, Mass., is a two stage amplifier employing one -24 tube in the first stage, followed by four type -47 pentode tubes in the output stage. The pentodes are connected in a parallel push-pull arrangement.

There is a very logical engineering reason for doing this. If a pentode tube is used singly and the conventional way is employed to obtain the bias voltage by an I.R. drop through a resistor, the sensitivity of the tube is such that this resistor is of a very low value. In order to by-pass the audio frequencies successfully, it is necessary to employ a very large capacity across this resistor. By using the push-pull arrangement, the necessity of by-passing this resistor is eliminated but the push-pull method of connection doubles the plate impedance of the tube which is initially very high.

In order to drop the plate impedance to a value which will be commercially acceptable, two tubes are placed in parallel in the push-pull stage, thus reducing the impedance value to that of one tube. When this arrangement is used it is necessary that two -80 type of rectifiers be employed in parallel to deliver the necessary current for the tubes.

The Model GA-80 amplifier has an unusually good frequency characteristic and will provide approximately 10 to 12 watts of undistorted energy to the speaker. The input is directly to the grid of the -24 tube, while the output is from the plates of the pentodes and "B" plus.

The input circuit is practically universal and may be used with values of impedance from 500 ohms up. When used with a microphone it is only necessary to add a microphone transformer, the secondary of which is connected directly to the input of the amplifier. Button current for the microphone can be secured by means of dry batteries if desired.

▲

SOUND-ON-FILM

What may be a life-line to small exhibitors, is the recent announcement of the S.O.S. Corp., 1600 Broadway, New York City, of a new a-c. operated sound-on-film for two projectors, which is being provided at $495.00 complete.

The S.O.S. equipment consists of two sound heads of standard make complete with photoelectric cells; optical systems; exciter lamps; lamp mounts; motor brackets; a-c. power supply containing fader and photocell balancers.

▲

TESTS BLOOD ELECTRICALLY

The accuracy of blood and other physiological analyses, which often depends upon the accuracy of color observation on the part of the analyst, has been enhanced by the development of an electric eye which can be carefully calibrated in reference to sensitivity to different colors. George Lewis, vice-president of the Arcturus Radio Tube Company, Newark, N. J., manufacturers of the electric eye, describes this photoelectric principle as an aid in such work.

"The human eye," declares Mr. Lewis, "almost invariably suffers to an extent from color blindness. Some persons are more color blind than others, and most of us will find that one eye sees objects with a slightly different shade than the other. This can be noticed by looking at a highly colored picture first with one eye and then with the other. Color blindness, slight or even acute, has little effect upon our success in life, if we are lawyers, automobile mechanics and about seventy-five per cent of all possible trades and professions. But when it comes to blood and other physiological analysis, where color is often a determining factor, an electric eye, such as the photoelectric cell, which never suffers from color blindness, or even retinal fatigue (which may affect even the normal eye) is a considerable contribution to the accuracy of results.

"The photoelectric eye can detect color differences beyond the sensitivity of the best human eye, and can relay its decision to amplifying apparatus that will indicate the color or variation from a standard color on a printed chart for a permanent and accurate record.

"This scientific development is an invaluable contribution to the medical profession and should abet the high peak of efficiency for which physicians are striving."

▲

NEW BELL & HOWELL STANDARD CAMERA SILENT UNIT "I" MECHANISM

All cameramen are familiar with the fixed type of registering pilot pin which was an exclusive development of the Bell & Howell Company for their standard cameras.

Since the inception of sound, there has been a need for a mechanism that would give the positive and particularly exact registration obtained with the familiar B & H pilot pin mechanism, but which would be silent enough to use on a sound stage. The Bell & Howell Company is, therefore, particularly pleased to advise that this has been accomplished in the new Silent Unit "I" pilot pin mechanism.

The little roller which engages in the main cam is now made of fibre, and the two slides which engage on the periphery of the main cam are equipped with fibre inserts. The oscillating rocker arm and register leaf parts are cut away and lightened as much as possible without sacrifice of rigidity and safety.

While these silence the mechanism considerably, two other improvements have been developed for further silencing the camera equipped with this mechanism.

First, the camera itself has been equipped with a special cam. The stroke of this special cam is about one-half of that employed in the regular camera. The idea of this is that the shortened cam controls the stroke of the register leaves exactly to the minimum possible limits of movement necessary to secure perfect results. The cam is arranged so as to prevent the register leaves from "slapping" against the aperture, thus eliminating the main source of noise.

The second improvement is the little ball bearing roller assemblies, one set of which is installed in the camera frame itself, and the other set in the angle plate of the mechanism. These rollers serve to control the loop.

All in all, this development represents a definite improvement. It is attracting great attention due to the fact that the mechanism can be readily adapted to take bi-pack films, thus giving a silent, color camera. By merely interchanging mechanisms, regular black and white pictures can be obtained without adjustment to the focusing ground glass or any other makeshift arrangement for compensating for the difference in the focal planes of regular and bi-pack films.

▲

ONE-PIECE DIAPHRAGM WITH FLEXING ACTION

Extreme flexing for easy pumping action so essential to full scale reproduction of music, together with a one-piece construction for ready assembly at lowest cost, is achieved in the latest type Burtex diaphragm developed by the Stevens Manufacturing Corporation, 42 Spring Street, Newark, N. J.

The new Burtex diaphragm comprises cone, voice-coil mounting, flexing member and mounting ring, all in a single piece of impregnated cloth. The flexing member is in the form of several concentric ridges made in the cloth which, at that point, is treated by a special process to produce the desired degree of pliability. Meanwhile, cone, voice-coil mounting and mounting ring retain the desired stiffness.

Instead of the usual practice of an assembled cone with leather flexing, rim and cardboard mounting ring, the new Burtex diaphragm is a one-piece unit ready to receive the voice coil and be mounted in the loudspeaker basket. The flexing member has the desired pliability for a free motion of the diaphragm, which is immediately noted in the bass response and general richness of the tone. There is no danger of losing the tone quality in mounting this diaphragm, nor is there danger of the diaphragm sagging. Doing away with the slow and costly assembly of the usual leather mounted cone, and insuring a uniform product, the new Burtex diaphragm represents a considerable saving in loudspeaker production cost while providing a new conception of tone quality.

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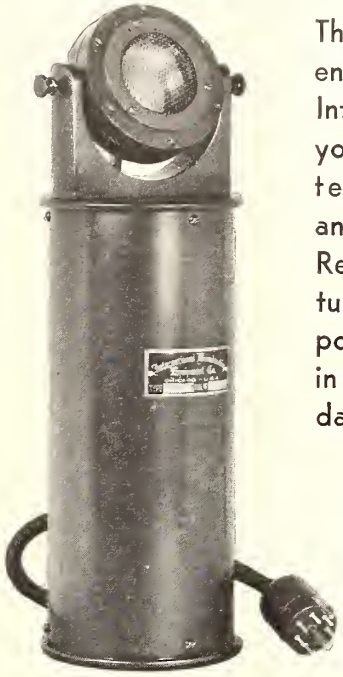

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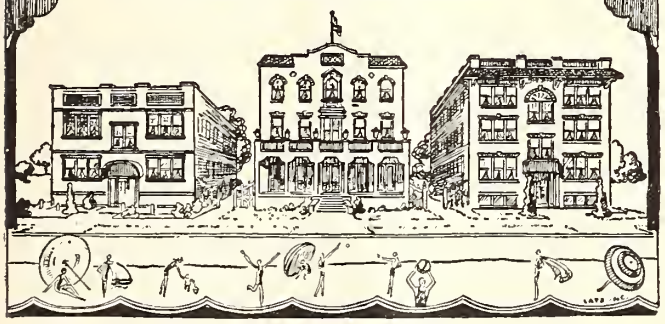

A New Volume Control

Front View of a TYPE 652 Volume Control
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Development and a rigorous service test have just been completed on a radically new type of volume control for mixer control work in recording and broadcast studios. Compactness, ease of mounting, and freedom from "whip" and dirt noises are important features.

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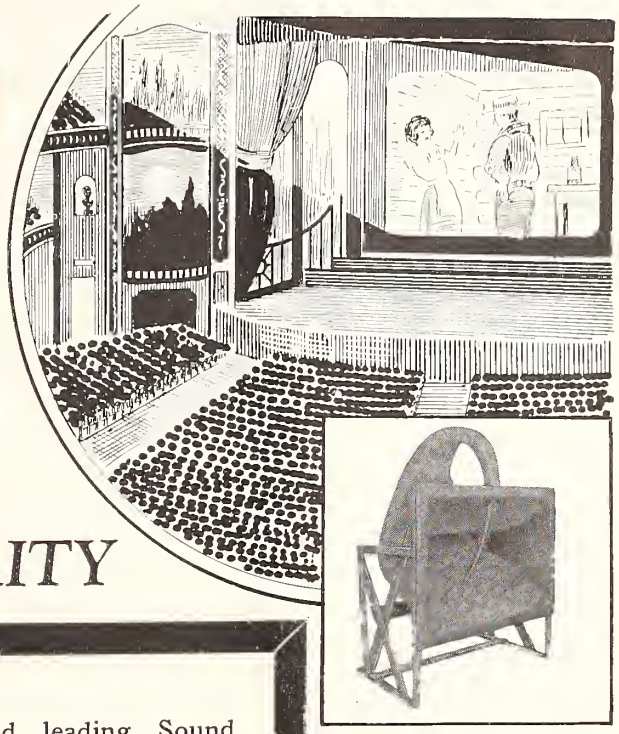

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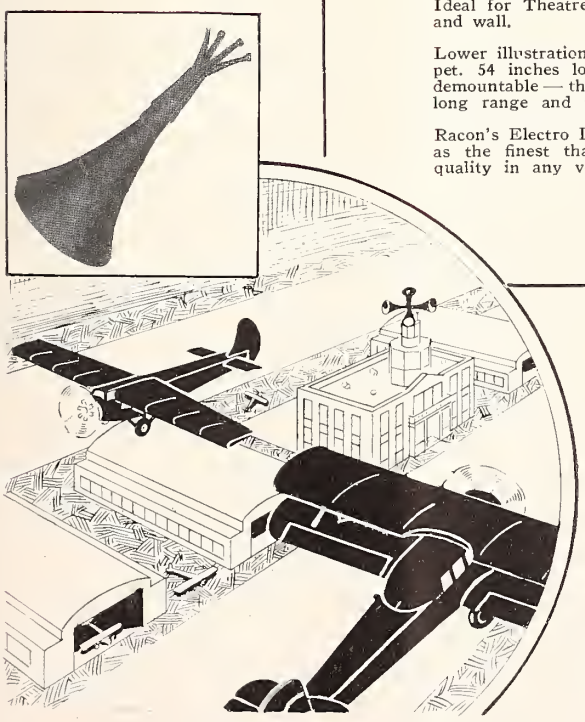

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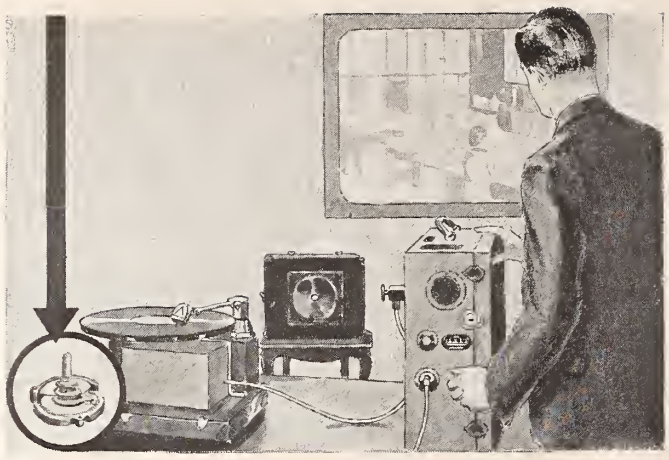

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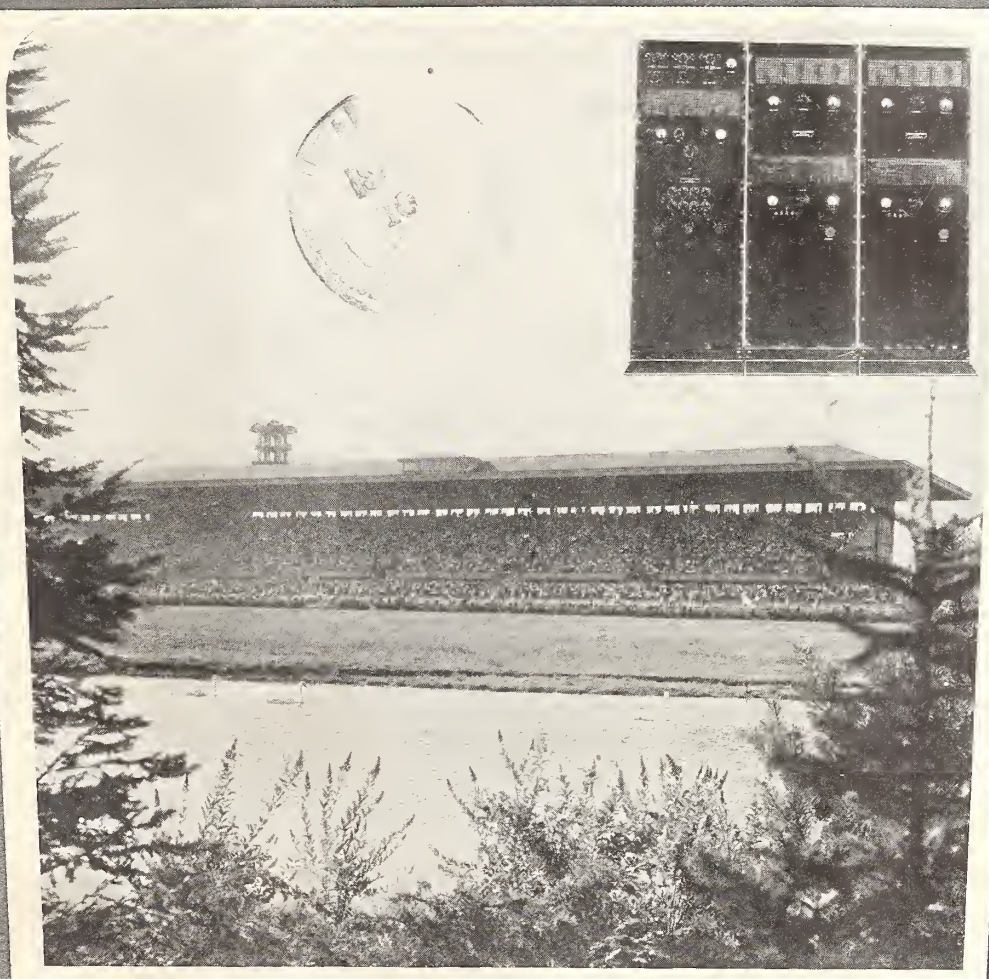

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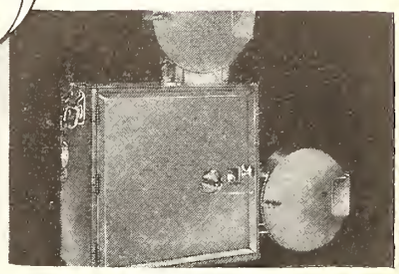

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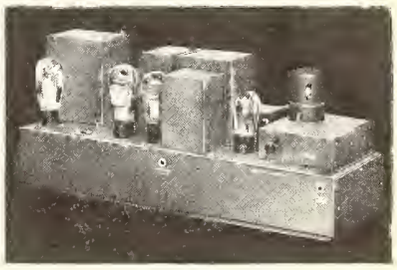

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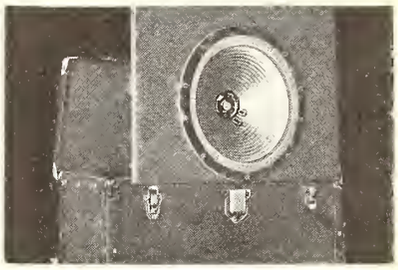

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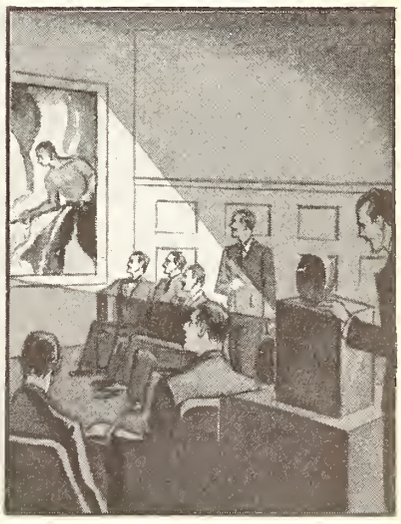

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Editorial

SEPTEMBER, 1931

WHAT PER CENT DIALOGUE?

A SURVEY stated recently to have been conducted among "more than one hundred" exhibitors, is reported to have shown that approximately 25 per cent. dialogue is "the right amount."

The question submitted was: "What do you consider the proper amount of dialogue for the general run of pictures?" The exhibitors interrogated are reported to have indicated varying quantities from 20 per cent. and "no more than the footage previously used for titles," to 75 per cent. "in certain cases, depending upon the picture," with the average working out as 30 per cent.

The exhibitors queried as to whether their patrons would welcome "a return to all silents," all replied "no," "doubtful," or gave similar negative replies.

It is interesting to learn that numerous exhibitors recommended that better utilization of musical background should be employed in film productions.

From our understanding of the situation the percentage reported appears quite low. Of course, it is to be recognized that there is a difference between per cent. of pictures with sound, and per cent. of dialogue per picture. It may be that if the questionnaire were sent to as many as 1000 managers located in representative districts that the percentage of dialogue would be nearer 50 than 30.

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SOUND AND PICTURE PROJECTION IN EDUCATION

VARIOUS well organized surveys have been carried on with the object of learning whether advantages may not be gained in public and high school instruction by employing the facilities of sound and light projection.

It was necessary only for parents to note from time to time the voluminous pronouncements emanating from church organizations to the effect that the modern "movie" is a powerful influence for good or for evil. Whether in any picturization the influence is good or evil, it is realized that the movies are attention compelling and effective in transferring ideas and knowledge from one person to another.

To utilize to the full these ready facilities for formal instruction in schools it will be necessary to enlist the interest of educators and Boards of Education. Also, some agency outside of present educational direction will have to work out a new technique of instruction which will provide more useful and less expensive methods of instruction than those now in use.

The present widespread dissatisfaction of educators themselves, and the swelling tide of criticism by the public, in regard to the present product of American educational institutions, presents a situation which is a real opportunity for a revolution in instructional methods and in educational material.

Another element, and one which is likely to apply expedition to present surveys, is that the growing cost of education per year per pupil has in recent years added burdens to taxpayers which quickly will have to be lightened. It is here that modern equipment, a new technique of education, and a revision of ideas as to what constitutes useful education, enter for serious consideration.

If those who are giving thought to this subject, in a promotional way, recognize that the thing they have to sell is more useful education, more thoroughly taught, and at lowered costs, they will succeed in a period of time perhaps directly proportional to the completeness with which these three requirements are met in what they propose.

It will not do to try to sell to present school officials something to be added to present facilities. This would no doubt suit these officials best, but would defeat the requirement of lower costs. The system that can be sold to the people is one that will replace much of the antiquated, bureaucratic organization now in control, a system that will relieve taxpayers of excessive costs and one that will make possible a school product better equipped for respectable, gainful employment.

Donald McNicol

Editor

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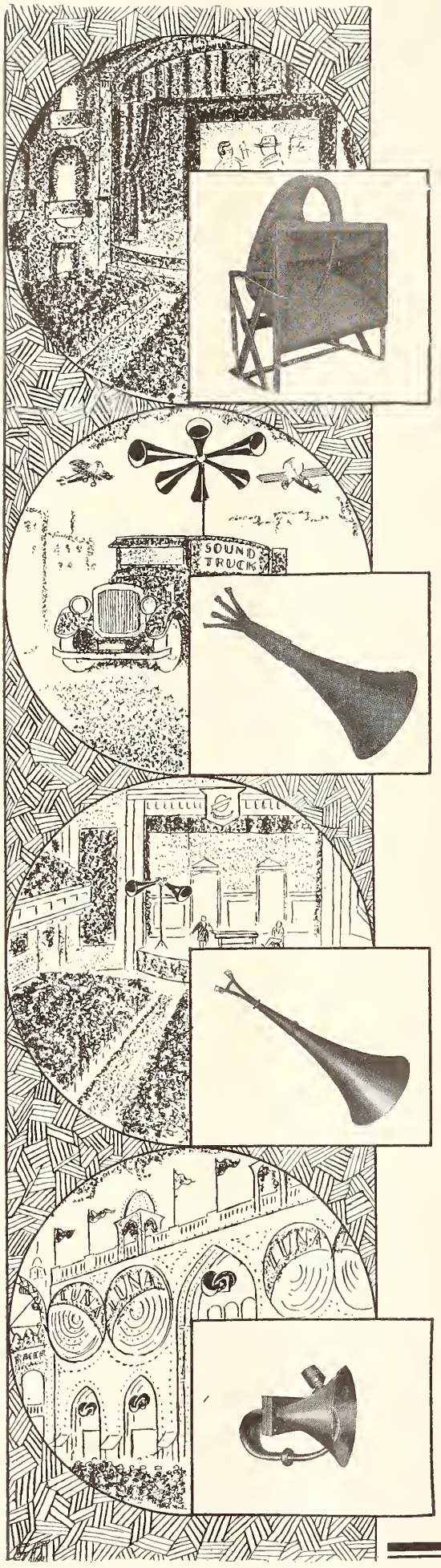

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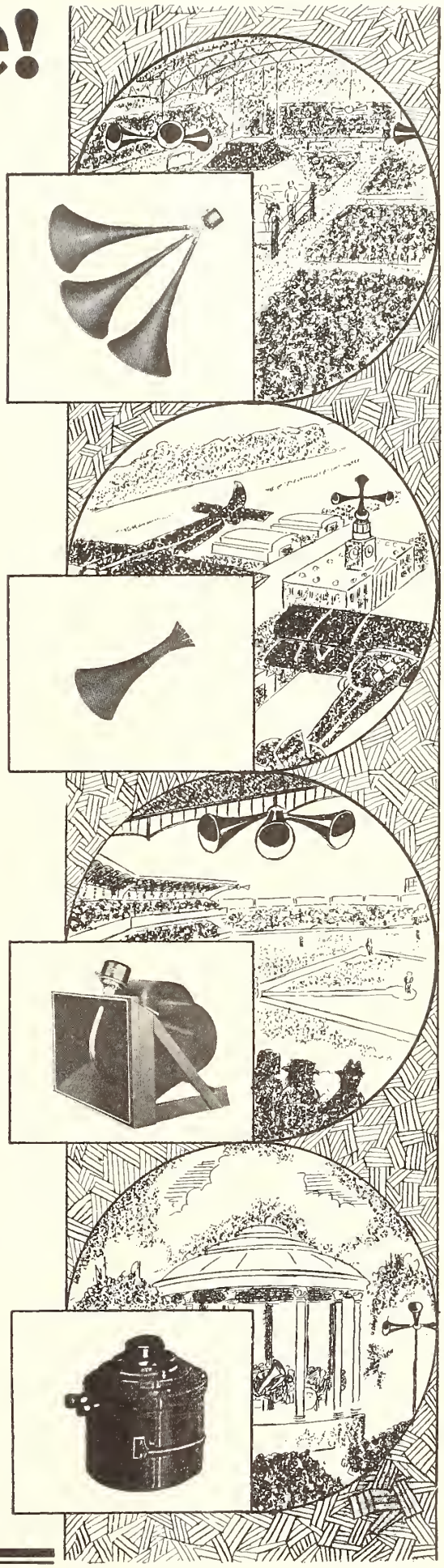

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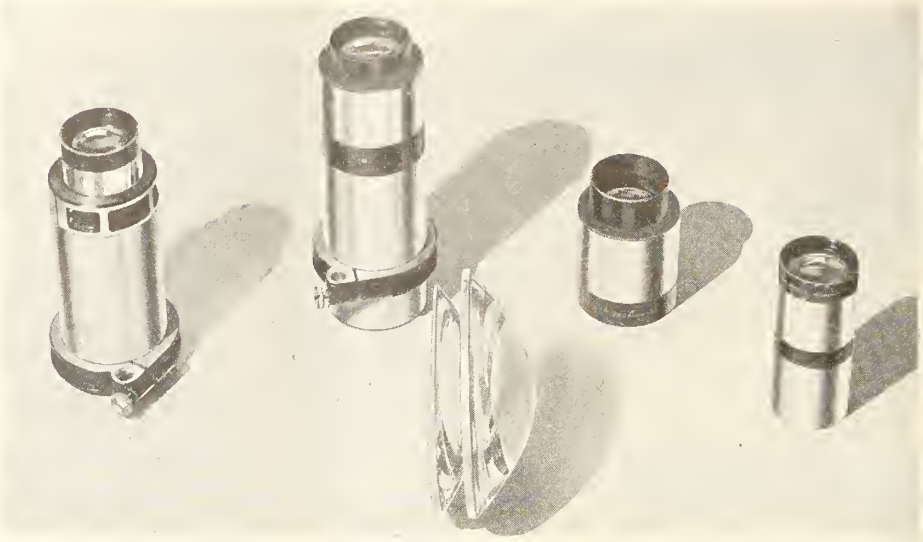

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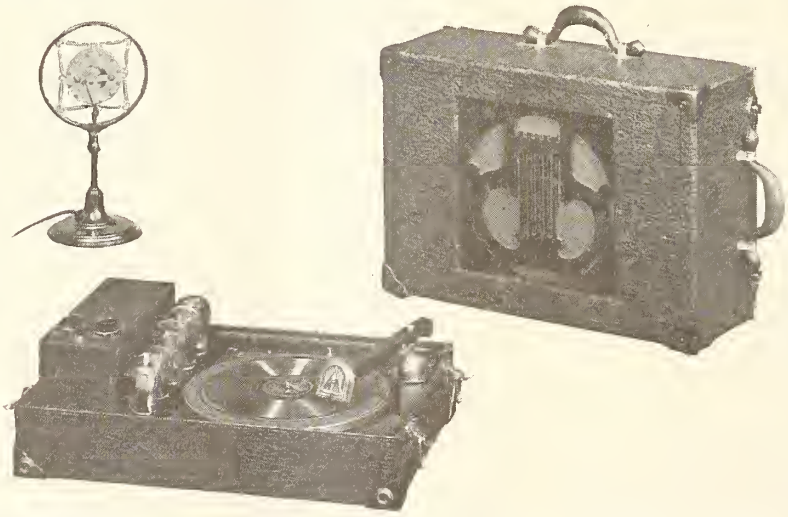

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Projection Engineering

SEPTEMBER, 1931

Adjustments for light valve recording

By C. B. Gordon-Sale

THE general arrangement and details of the light valve and its recording machine are fairly well appreciated throughout the industry but there appears to be a certain amount of misunderstanding as to its usage. In the following brief article, therefore, a few notes are given on the subject which it is hoped may prove of interest to those who, while associated with the recording side of the industry, are not yet definitely called upon to operate the machine themselves.

In the first place the light valve is attached to the base of the recording machine between the recorder lamp and the film driving mechanism. It is of two distinct parts; first, the field coil, and, second, the light valve proper which carries the loop of duralumin ribbon which modulates the light beam. The mound shaped projection on the light valve over which the loop passes actually forms one pole of a magnet and the magnetic circuit is completed only when the light valve is screwed in position. The slit through the centre of this projection is continued through the core of the electromagnet. In fact, one may consider the whole device as a hollow electromagnet, the modulating beam passing directly through the aperture, its path being interrupted in the gap by the ribbon. The slit in the central pole pieces is .008 inch wide. When the light valve is fastened in position the gap between the poles of the electromagnet itself and the light valve proper is approximately .010 inch and therefore the flux density is very high, making for the greatest possible efficiency. So important is cleanliness to the operation of the light valve that the yoke when not actually being used is removed from the machine and kept in a dessicator completely free from moisture and dust.

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For proper film recording lamp and ribbon must be accurately adjusted.

Stringing the Valve

The actual stringing of the light valve is a delicate operation akin to that of fitting cords to a violin or similar type of musical instrument. Before a light valve is attached to a recording machine it has to be examined under a microscope, preferably calibrated, so that gaps and similar dimensions can be checked. An essential is that the slit through the yoke should be absolutely parallel; unless this be the case there is considerable probability of light leakage during heavy modulation. A little consideration emphasizes this necessity, since the small section of ribbon is only just sufficient to enable maximum movement to take place without the edge of the slot being exposed. Maximum modulation is in fact reached when the two sides of the ribbon are moved .002 inch, that is to say .004 apart. Although naturally all parts have been carefully inspected in manufacture and after passing from the stores, the limits of accuracy demanded are so fine that clumsiness in shipment or in handling may easily throw the light valve out of adjustment. The assembly of the ribbon to a light valve yoke is accomplished by means of a special jig. First of all the tensioning roller is adjusted so that it lies at an angle of 45° to a line passing through the long dimension of the slot. The four spacing rollers are then opened out so that they are about one eighth inch apart. A strip of ribbon just under a foot long is then taken and one end inserted in the slot in the capstan screw. Two or three turns of this screw are then given and the ribbon is threaded through the jaws over the pole-face and around the spring tension roller, and, finally, in the same manner back to the second capstan screw where it is given a couple of turns. Any excess ribbon is then cut off. In performing this operation the greatest care must be taken that no twists occur. It is not sufficient to ensure that twisting is not apparent on the finished job. More than this the actual handling must be such that not the slightest kink is introduced as otherwise it is bound to show up in recording even though not apparent to the eye. Rough adjustment then takes place by means of the capstan screws which are rotated until the tension arm stands exactly at right angles through the line passing through the longest dimension of the slit in the pole yoke.

Examination

When the above operations are completed the jig carrying the light valve is placed under a microscope and examined minutely to see that the edges are perfectly straight. At this junction it is well to point out that sometimes there are inherent faults in ribbons which render them unfit for recording even though they are treated properly in threading. The manufacture of duralumin ribbons for light valves is a specialized art and, in fact, demonstrates forcibly the great improvements of recent years in wire drawing. On no account should ribbon showing the slightest defect be employed as it is quite possible for a small piece of apparatus like this to cost a very large sum both as regards spoiled film stock and also in time wasted looking for trouble. In the writer's experience troubles in the first place attributed to faulty film have finally been traced down to defects of light valve ribbons. This might not be the case were the person stringing the valve in attendance during recording but this cannot always be depended upon.

The parallelism of the two sides of the ribbon is adjusted with the device itself still under the microscope, the usual set being such that the inner or adjacent edges of the ribbon are about .002 inch apart and equally spaced on both sides of an imaginary centre line passing lengthwise through the slot.

Tuning

The light valve has to be tuned so that it has a natural frequency of approximately 7,000 cycles per second. The reason for this is that there shall be no peak effect within the usual musical range. Nevertheless, the rising fre-

quency response makes its presence felt somewhat below the actual point of tuning, but this is generally to the good since the sum total of sound processes in the recording chain usually leaves a drop off at higher frequencies. Incidentally it may be mentioned that in the oscillator method of recording tuning takes place somewhat lower, usually round about 6,000 cycles where under modern conditions the peak definitely makes its presence apparent on the sound track. Putting the matter briefly: in tuning the light valve a circuit oscillating at 7,000 cycles per second is connected directly to the light valve which therefore vibrates at the same frequency modulating the beam of light from the recorder lamp which falls directly upon a photoelectric cell included in the body of the recording machine. This is connected via a series of amplifiers to a film indicator. The tension of the ribbon in the light valve is then gradually increased and as soon as the resonant frequency of 7,000 cycles is reached the indicator needle gives a definite "kick" due to natural, and forced vibrations becoming synchronized.

Considerable experience is necessary before tuning can be carried out with accuracy, for, although there is a definite kick in the reading of the film indicator, this is usually preceded by a gradual rise. If the ribbons are tightened any further the meter reading begins to fall. Adjustment of the tension should therefore aim to be such that the maximum deflection of the meter takes place. In practice it is common to achieve the greatest accuracy by actually passing the 7,000 cycle mark and then slightly relieving tension so as to return to the actual figure. The reason why this is better than straight tuning is not always appreciated.

Careful tests show that the reason for higher accuracy is that by de-tuning slight frictional effects on the various parts of the contacting path of the ribbon are relieved. If, instead, tensioning alone is carried out, friction is bound to be developed, and in practice it will gradually become relieved, thereby resulting in a fall of the point of resonance. Of course, when we speak of frictional effects in the case of a device of this type we are referring to quantities entirely microscopic in character and discernible only to the most sensitive of instruments.

Sometimes trouble arises because the roller on the tension arm is not running perfectly free. This causes the two sides of the ribbon to be differently tensioned, thus producing a double resonance point which is highly objectionable. When tuning the light valve a careful check should always be made to ensure that such a condition does not exist. This test is carried out by varying the frequency of the oscillator coupled to the light valve from between about 3,000 to 8,000 cycles per second in operating steps of 200 cycles. If frictional effects be present, there will be two definite peaks to the reading of the meter. As a matter of fact it is almost a physical impossibility for both sides of the ribbon to resonate at exactly the same frequency, and tuning is considered satisfactory providing the two resonant points fall within 100 cycles of one another on either side of the nominal tuned frequency of 7,000 cycles.

If this check indicates that there is something amiss, it is a good plan to slightly decrease the tension of the ribbons and at the same time lightly tap the tension roller, being careful not to touch the ribbon itself. Metal should not be employed for this purpose, an ordinary lead pencil serving quite well. Another method utilizes the fact of the existence of two capstan screws. In other words, tuning takes place not from one side of the ribbon alone but from both sides. Theoretically, this is the best method for tuning, but naturally it takes somewhat longer.

When everything is found satisfactory the screws should be carefully locked in place with a steady though not violent effort. This by the way, is important as brute strength is likely to affect the resonant frequency.

When tuning is complete the light valve is removed from the field coil and the parallelism of both sides of the ribbon is again checked by microscope. Sometimes the operation of tuning affects this other factor and the four spacing screws have to be adjusted once more. The error, however, is likely to be very slight indeed and in case of emergency it may not be necessary to check the resonant point. However, wherever possible such checking should take place. When testing and carrying adjustments on the light valve make sure that the speech connections to both sides of the ribbon are broken prior to the field current being turned either on or off. If this procedure be not adhered to the sudden change of flux may seriously damage the ribbon itself even to the extent of burning it out.

QUESTIONS AND ANSWERS

In an early issue of Projection Engineering *will appear a new series of technical questions for projectionists. The correct answers will be published in subsequent issues.*

It is probable that examinations will be held which will give opportunity to students to show how thoroughly they have studied.

The Recorder Lamp

The adjustment of the recorder lamp is another operation requiring more than a moderate amount of care. The lamp itself is usually of the 6-volt variety taking about 14 amperes and is fed from a 12-volt storage battery, the potential of which is adjusted by means of a rheostat and controlled by an ammeter. First of all the image of the filament has to be focused on the pole-face of the field coil. For convenience the light valve is usually removed during this operation. By adjustment of the rheostat the filament current is usually cut down to some 7 or 8 amperes which sharpens the filament image making it easier for focusing. First of all the lamp is adjusted vertically until the strip of light appears centrally upon the pole-piece slot. Next lateral adjustment takes place by slackening off the clamping nuts and moving the lamp backwards and forward until the image on the filament appears sharp; all lock nuts are then tightened. As is apparent the procedure is practically identical with that employed in setting the exciting lamp in projecting mechanisms.

Mean Density

So that the effect of the unmodulated light valve shall produce the mean density value of sound track the light intensity of the recording lamp has to be carefully adjusted by means of the rheostat control. To this end each recording lamp has to be calibrated. First of all the lamp is fixed in the manner previously described and then a length of film is run through the machine at recording speed with both field coil and light valve on open circuit. The filament current of the recording lamp is then changed in steps of an ampere through a range of 10 to 18 amperes. Greater current than this should not be passed through the lamps even for the shortest of periods as otherwise they may suffer damage at least to the extent of shortening their service life. The density of the resultant unmodulated sound tracks can then be measured in the usual manner by means of a densitometer after developing to the customary gamma value. An exposure of a sensitometric strip on the test sample of film is necessary. The densities of the different exposures are then plotted against filament current and when joined by a curve present the calibration data desired. Without going further into technical details it will be apparent from this curve that the mean unmodulated density may be determined

(*Concluded on page* 22)

Increasing the usefulness of theatre sound equipment

By Gordon S. Mitchell*

The Prince of Wales using his Filmo movie camera at Arequipa, Peru. His brother, Prince George, is directly behind him.

IN many motion picture theatres it has become practice to increase the usefulness of the sound amplification and projection equipment. It will be the purpose of this paper to point out some of the uses, other than for audible picture presentation, to which this apparatus may be put—to show the application of theatre sound projection apparatus to more or less orthodox public-address use.

There has been manufactured for use with theatre equipment a set which allows the regular projection equipment to be used for paging members of the audience or for making announcements of coming attractions or other timely topics which it might be desired to place before the audience. This set comprises a microphone, a control and switch panel and associated equipment which makes it possible to project the microphone output over the regular theatre horns.

The usual practice is to have the announcing equipment placed either in the theatre manager's office or in a small acoustically treated room adjacent to the projection booth. The microphone is the usual two-button carbon microphone with an associated cord and plug which fits into a jack on the control box. On the control box there are two signal lights, which are so connected that the green light goes on when the circuit is cleared from the projection booth and signifies to the announcer that all is ready for him to go ahead. The announcer then throws the key on his control box, which lights the red light and signifies that the system is open throughout and that the announcer is "on the air." The booth equipment is modified somewhat when the system includes announcing facilities. A switch panel on the amplifying rack in the booth contains a key which allows the system to be operated on synchronous or non-synchronous reproduction or for announcing through the microphone. This panel also contains signal lights which visually show which type of reproduction the system is set for and a light which indicates to the projectionist when the announcer is on.

On this panel also is a repeating coil with which are associated the circuits for supplying current to the buttons of the microphone and the jacks into which may be inserted a plug connected to a meter for measuring this microphone current. There is a relay which embraces a pair of normally closed contacts which short circuit the output of the repeating coil (also mounted on this panel), which is operated by the key on the announcer's control panel. Thus current is furnished the buttons of the microphone only so long as the key on the announcer's panel is on the "announce" position. This places final control of the system in the hands of the announcer.

The setup of equipment allowing audible announcements to pass through the theatre system is simple. At a predetermined point in the program—rehearsal of this portion is of as great importance as rehearsal of the stage or picture portion—the announcer inserts the plug of the microphone into the proper jack and awaits the signal from the booth that the system is in readiness. The projectionist brings his fader to zero and simultaneously throws the key to the "announce" position on the control panel. This lights the green light indicating to the announcer that it is okay for him to go ahead. He then throws his key, thus energizing the microphone and placing himself "on the air." A rehearsal will have indicated whether or not it is necessary to change the volume setting for the announcements depending upon the peculiarities of the announcer's voice and his distance from the microphone.

For Stage Presentations

An application of public-address principles to theatre use which has become widespread of late is in reinforcing the audible portions of stage presentations. In the larger de luxe houses throughout the country it has become usual practice to present a prologue featuring dancing and singing in conjunction with the picture portion of the program. These presentations oftentimes may be increased in effectiveness by a judicious use of sound amplification equipment.

The microphones are usually placed in the footlight trough, or if special conditions necessitate, about the stage concealed by vases or other props. The control equipment is usually mounted on a separate rack, either in the projection booth or at some point backstage where the operator can see all that transpires and regulate his equipment accordingly. (The services of an additional operator other than the regular projectionist is in general necessary when using sound equipment in this manner).

On the control equipment rack there will be eight panels, including a miscellaneous equipment panel, two jack panels, two volume control panels, a volume indicator panel, a rheostat and key panel, and a horn control panel. The microphone circuits from the stage

Electrical Engineer, Sound Department, Universal Pictures Corpn.

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Theatre auxiliary sound equipment has many uses in the modern theatre.

terminate in jacks on one of the jack panels, which provides for twenty microphone circuits. By means of patch cords any one of these microphone circuits may be connected to jacks on the second jack panel which in their turn are connected through an individual control channel to the main volume control circuit. There are eight individual control circuits for supplying current to the microphones, with a means for measuring and controlling the current in each circuit.

Circuit Control

The circuits are so arranged that all control channels in use are connected through a common output circuit which leads to the main volume control potentiometer on the second volume control panel. A signal lamp mounted on this panel indicates that the amplifiers in the projection booth are ready for service. An amplifier is provided at the control rack in order that the loss engendered in the control and switching circuits may be compensated for, and also that the voice currents may be reinforced before being despatched to the main amplifiers if necessary. The main amplifiers, of course, remain under the control of the projectionist in the booth.

In order to maintain the illusion of reality, the horns should be placed as near the stage as possible, although care must be exercised in order that the microphones are not placed in front of the projectors or singing in the system will result. It is of interest to note that for this type of work, an ordinary horn will give good results. A horn which responds to a narrower frequency band will serve the purposes of audible reinforcement, although it would prove unsatisfactory for projecting sound for motion pictures. This makes it possible to use a folded exponential type horn with a six-foot air column, which horn may be mounted behind the proscenium arch and above the stage for the stage presentations when it is impossible, due to architectural features of the building to place the regular horns in such a position that they will operate satisfactorily in this service. It is important that the horns projecting this portion of the program be carefully placed or unsatisfactory results will follow. The entire illusion of reality depends upon proper placement of the projector horns. If it is impossible to place the horns in such a position that the sound seems to be coming from the stage direct, either behind cut out grille work above the stage or behind the proscenium arch above or at the sides of the stage, it will oftentimes be possible to hang a large ornamental fixture from the ceiling containing a projector horn, so decorated that it will harmonize with the surrounding architecture.

As before mentioned, an operator should be at hand who is responsible for the operation of the equipment during the stage portion of the show. After determining that the microphone circuits are clear, the projectionist throws a switch which places control of the system in the hands of the operator who then becomes the most important single factor in the success or failure of the presentation. The operator is able to follow proceedings on the stage by vision and with the aid of a monitor horn and visual volume indicator. Equipment is provided with a shelf just below the volume control panel upon which the operator can rest his arm. This is a very desirable feature inasmuch as it is generally necessary to constantly adjust the controls in order to follow the changes on the stage.

A Typical Installation

The Pantages Theatre in Hollywood presents an interesting illustration of the use of sound equipment for enhancing the beauty and effect of stage presentations. This theatre is relatively new and embraces all of the innovations which are to be found in most up to date theatres. The theatre uses amplification equipment for reinforcing the volume of the audible portion of the stage presentations, making the smallest voiced performer heard easily throughout the auditorium.

There recently appeared in a stage presentation a young lady crooner, who is rather noted among her acquaintances for her small voice. This young lady had achieved a measure of success in singing over the radio, where by microphone technique she was enabled to retain the low volume characteristics of her voice and increase thus the pleasing qualities for which she is known. However, several of her friends were rather doubtful of her ability to project her voice sufficiently in the theatre. A pleasant surprise was at hand for these doubters—many of whom, untrained in the arts of sound amplification are still wondering just how it was done.

At the rise of the curtain, the young lady was seen standing upon a raised platform, with what was ostensibly a music rack placed slightly to one side and a bit in front of her. On this stand, concealed from the audience was placed a microphone which served to pick up the weak voice waves. These waves, electrically converted, were passed through amplifiers and projectors on to an unsuspecting audience. So expertly was the presentation handled that the performer was able to sing in a very low voice, retaining all the intimacy of that type singing, and her voice was amplified and projected in such a manner as to leave the audience unaware of the electrical aid given.

In addition to the regular features of such an installation, the equipment in this theatre is used to bring out and increase striking orchestral effects during the overture which is a weekly feature of the program. A microphone is placed in the orchestra pit near the instrument or group of instruments which it is desired to feature. Microphones placed on short stands just in front of the ornamental railing which surrounds the orchestra (out of sight of the audience) serve to pick up the remainder of the instruments. Thus by a manipulation of the mixing control, the music from the desired instrument or group is made to stand out high above the rest of the orchestra. Of course, when such effects are attempted extreme care must be exercised or the performance will be overdone and the effect lost.

The equipment in this theatre is so arranged that in case of a breakdown of the regular sound projection equipment, the public-address system may be used as a substitute. The public-address system comprises separate projectors, amplifiers and controls and in effect places an entirely separate substitute sound system at the disposal of the management should trouble develop. The control equipment is housed in a soundproof booth adjacent to and on a level with the projection booth, the two being connected by both visual and telephonic communication systems. Six large and separate projectors are placed around the proscenium arch, as well as one extra large projector placed directly over the center of the auditorium hanging from ceiling. Two small horns high up on the ceiling and towards the rear of the auditorium take care of the balcony seats.

Broadcasting From the Theatre

The Pantages Theatre is also connected with one of the chain broadcasting systems, broadcasting the stage presentation direct from the theatre weekly. All controls for the broadcast of programs from the stage are handled from the public-address booth.

Another use to which sound equipment installed in the theatre may be put is in aiding the director in rehearsing stage presentations. Probably the foremost exponent of the use of sound amplification equipment in rehearsing his shows is S. L. Rothafel. It has been well said that a Roxy presentation is a combination of the man himself and his sound equipment. The perfect coordination of every presentation at the Roxy Theatre is a direct result of the use of public-address equipment.

Loudspeakers are placed throughout the theatre at strategic points through which Roxy is able to address anyone

in his crew whom he may wish to instruct. Men backstage at the light switchboards, the electrician's control board, the Kino booth and on the stage spot bridges may be addressed direct by Roxy who sits far back in the theatre with a microphone through which he issues his orders. The lighting effects, for which this theatre is so famous are executed with almost lightning like rapidity. The director gives an order into the microphone and sees it almost instantly carried out; he can change his order immediately if the effect achieved does not please him. This use of the loudspeaking system direct does away with the old method of issuing orders into a telephone to a stage manager, with the consequent delay necessitated by the relaying of the order through a third party.

Even during the first few performances of a new presentation, Roxy sits in the audience, a small transmitter near at hand through which he issues orders for any changes he may desire. The system is then connected to small loudspeakers located backstage near the electrician's board and the spot bridges.

The system has been set up so that with a small modification of equipment a microphone may be connected into the circuit and placed backstage, enabling the men to answer any question asked by the director or call for additional instruction if necessary. This modification permits maximum flexibility to be achieved by the system as used for directing rehearsals.

The application of sound equipment in the theatre to uses other than the projection of motion picture sound engenders no new principles of operation. As a concluding thought it should be borne in mind that with the operator of the equipment—(exactly as does the success of the sound motion picture ultimately depend upon the projectionist)—lies the responsibility for the success or failure of the presentation. While this responsibility, although present, is not of such great importance in uses other than for the reinforcement of the audible portions of the stage show, it is of extreme importance in that particular application. The equipment operator may nullify the efforts of many persons in presenting a suitable production to the audience by an unsatisfactory manipulation of the controls. Hence it is of the utmost importance that if satisfaction is to be realized from the use of the equipment, the operator be fully cognizant of his responsibility. Upon him rests final responsibility for the success of the presentation.

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Splices at sound track

AN IMPROVED system of treating the sound track at splices—a system eliminating methods of painting and at the same time successfully silencing splice noise—has come onto the market. The new method was described to the industry more than a year ago, but production of the necessary "blooper patches" and the simple block for applying them has only recently made it applicable in processing laboratories and projection rooms.

The introduction of this equipment came as a result of many requests that followed the announcement of the new patching process. The wide interest shown indicated that expenditures involved in acquiring tools to make the patchers and the patches would be justified.

The patching system obviates a condition in which imperfect painting of the sound track at splices frequently caused noises as objectionable as the extraneous sounds made by the reproducing system when an untreated patch went through. The older method caused more dissatisfaction in projection rooms than in laboratories, where skilled workers painting the sound track at hundreds of splices a day attained proficiency in the process. Even in the laboratories, however, it is believed that greater speed, together with assured accuracy, can be gained by the use of the new patching process.

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An improvement in sound track splicing methods which results in silencing splice noise, is a forward step which is worth noting.

In seeking a solution to the problem, the Eastman Kodak Research Laboratories first tried gummed paper, then decalcomania transfers, and then an opaque film material; but none of these materials for patches proved entirely satisfactory.

The material finally adopted was a very thin clear film base, coated with an emulsion and exposed and developed to produce opacity. The patches are five perforations long and they are cut in a shape designed to cover the sound track completely for a distance equal to the width of a standard splice, but tapering away toward each extremity until the sound track is entirely exposed. When a properly mounted patch passes through the reproducer the light reaching the photoelectric cell from the sound record is reduced gradually to an insignificant intensity and so continues until the splice has passed, after which the light passing through the sound record gradually attains its original intensity. The resulting diminution of sound lasts not long enough to be perceptible.

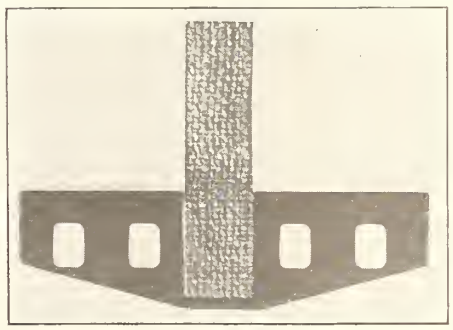

Fig. 1. Sound track splice.

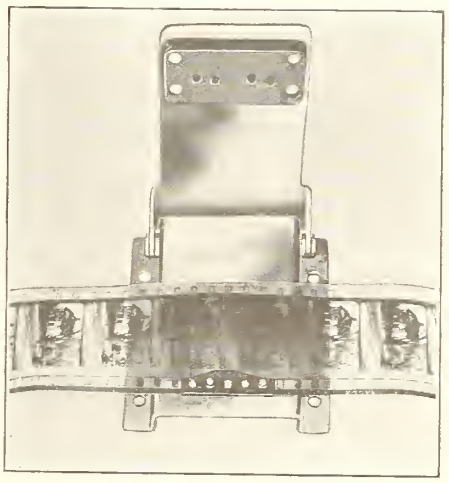

Fig. 2. The patcher.

Mounting of a patch, after completion of a splice, is very similar to the process of splicing. Four pins on the patcher fit the film perforations so closely that pressure clips for holding the film in place are unnecessary. A single stroke of a camel's hair brush is sufficient to apply cement to the shiny side of a patch, which comes into contact with the shiny side of the film. Five seconds' pressure with the pressure plate of the patcher is sufficient to permit drying of the cement.

Madison Square Garden takes the Sound Cure

By means of a new, suspended ceiling of sound absorbing material, the big arena is modernized for sound transmission.

AMERICA'S most famous indoor sports auditorium has taken the sound cure. The official diagnosis called the principal trouble excessive reverberation. Further analysis revealed the presence of too much noise and of acoustic reflections from some of the surfaces of the auditorium which caused echoes. All of these deficiencies combined to produce low intelligibility, resulting in complaints from customers that they could not understand the announcements from the center of the huge arena.

The public-address system assured adequate amplification so that the sound of the announcer's voice was loud in every part of the hall. The volume of sound was not enough alone to make the speech understandable. The public-address system was not at fault and the announcer was not at fault. The sound rolled around, producing a phenomenon called reverberation and echoes to such an extent that words could not be understood. Even when the hall was filled to capacity, the most favorable condition for the intelligible transmission of sound, the results were unsatisfactory.

The first step taken was to make a complete acoustic survey of Madison Square Garden. A series of measurements using the reverberation meter and other acoustic measuring apparatus revealed a condition of excessive reverberation and the existence of a noise level far too high for satisfactory hearing conditions. Graphic analysis of the plans of the arena, in connection with the data obtained from measurements, revealed the cause of the trouble and specifications were prepared covering the alterations which would have to be made to produce good conditions.

Reverberation tests showed a variation from 7.65 seconds with the auditorium empty to 2.96 seconds with an audience of approximately 18,000 people. The value of 7.65 seconds was obviously much greater than optimum or beat reverberation time of 3.0 seconds, which experience and theory indicate is most suitable in an enclosure of this size.

Analysis revealed that instead of absorbing sound the ceiling reflected it into the seating areas. Since the ceiling is very high, these reflections came back to the audience as echoes and continued to circulate around the arena as reverberation. In addition, the large amount of noise which entered the arena through the windows and from the entrances and lobby space reflected around the auditorium so that its volume was greatly intensified.

Two alternates were suggested to remedy this condition. First, covering the present ceiling with a material having a very high absorbing value, or, secondly, constructing a suspended ceiling beneath the sockets of the existing trusses, the suspended ceiling to be composed of sound absorbing materials.

The second course of treatment offered a somewhat greater improvement since in addition to introducing a large amount of acoustic absorption of the auditorium, it reduced the effected volume by several million cubic feet. The second alternative was decided upon and plans were drawn to erect a ceiling framework consisting of structural angles, which was hung from the trusses. Sections of sound absorbing rock wool blanket having an absorption of more than 50 percent., and which were self-supporting, were made up and laid into place on the steel framework. This makes it possible to remove sections whenever necessary in order to replace lights or hang lines for special events.

It took about ten days' time and $35,000.00 to give Madison Square Garden the sound cure. Alterations were all made under the supervision of

(*Concluded on page 22*)

View of new acoustic ceiling installed in Madison Square Garden to eliminate excessive reverberation and improve acoustic conditions.

Sound projection practice

Part I

THE Sound Committee, in preparing this report, has confined itself mainly to a consideration of the status of present-day practices in sound recording and reproducing. Some study has also been given to the possibilities of standardization as well as to those items which might well be investigated further.

Good Practices Recommend

Where a practice has proved itself worthy of usage it is the plan of the committee to recommend it for standardization to the Standards Committee of the society. It is recognized that in an art so comparatively young as sound recording and reproducing, care must be taken against premature attempts at standardization. The progress of development is so rapid and the technic of recording and reproduction is undergoing adjustment so quickly that premature attempts at standardization might prove a hindrance rather than a help. On the other hand, the moment any phase of the art becomes stabilized, it should be presented at once as a matter worthy of standardization throughout the industry.

In this report the committee intends to show a cross-sectional view of the newer and more important phases of sound recording and reproducing. It is not intended that the material presented here shall encroach upon the activities of the Progress Committee although there may unavoidably be some slight duplication.

Suggestions For Betterment

Neither the Committee nor the Society now has facilities to carry on investigations, but it can recommend what is of importance for further progress in the art. The Committee, therefore, feels it may be of considerable service in presenting to the Society and to the industry matters on which work should be done. Some of the items which have been suggested to the Committee as worthy of consideration have already received sufficient study to permit the formation of definite recommendations. In these cases, arguments for and against are presented and the Committee's conclusions submitted.

Status Report

Directional Sound Detectors. A directional sound detector comprises a device in which the efficiency of response is a function of the angle between the direction of incident sound and a reference axis in the system which coincides with the direction from which it is desired to receive the sound.

In general, there are two principles used in directional sound detectors, one amplifies the sounds desired by concentrating them and the other avoids or suppresses the unwanted sounds. Horn and reflector types employ both principles. The ribbon microphone and absorptive baffle make use of only the second.

Horns. Horns have been long used in conjunction with various types of sound reception apparatus, but have not been used for high-quality pickup due to the difficulty of obtaining a good frequency characteristic in spite of the apparent efficiency of this type of unit.

Reflectors. The use of reflectors for the reception and focusing of sound is well known. In order to receive sound pressure variations over a wide frequency range, it is necessary to use a reflector having large dimensions. Within practical limits of size, a reflector is likely to have a characteristic which will be better at the high end of the frequency scale than at the low end, although compensation for this effect can be applied.

Combination of Horn and Reflector. It is possible to combine the horn and reflector principles in a device which has a fairly good resultant frequency response. The directional properties, however, as limited by the design of a horn and a reflector, may not be uniform with frequency.

The directional characteristics of

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these devices have been found useful in eliminating undesired sounds and noises, particularly where the sound which it is desired to pick up is weak. The effectiveness has been greater for outdoor work where there is no reflected sound than for use in studios where reverberation is encountered.

Ribbon Microphone. A properly designed ribbon microphone may be made very directional. Its directional characteristic is practically independent of frequency because of its dimensions, and, by virtue of its directional effect, increases the distance from which acceptable sound may be picked up, in spite of the fact that it receives a relatively small amount of energy due to its size. It is also particularly effective in reducing unwanted sounds, such as camera noises and the like.

Absorptive Baffle. It has been found possible to design an absorptive baffle for a microphone in such a way that any sound coming from a direction not included in the throat angle of this absorptive structure will reach the diaphragm at a very much reduced intensity. This structure, while fairly large in dimensions in order to obtain the necessary absorption, is not dependent entirely upon the wavelength of the lowest frequency for its minimum dimension since the wave front remains practically undisturbed. This arrangement, of course, is no more efficient than the microphone would be without the absorptive device, but its sharp selectivity of the direction from which it effectively receives sound makes it appear promising.

Camera Silencing Devices

Silencing of cameras became necessary with the advent of talking pictures.

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Report of the Sound Committee of the Society of Motion Picture Engineers, Presented at the Hollywood Meeting, June, 1931. H. B. Santee is chairman of this committee.

While the ideal method would be to use a silent camera, until such perfection is attained, it is necessary to place the existing cameras in some form of silencing box. This, in the first place, took the form of a camera booth large enough to house one or more cameras and the cameramen. Being extremely cumbersome and heavy, it was in some cases very difficult to place on a set and of necessity soon gave way to handier methods.

During this preliminary stage, much thought and work went into the methods of camera maintenance which resulted in their being brought to a higher state of mechanical perfection than had ever before been attempted in the industry. It was also found that the commonly used means of interconnecting the camera and the camera drive motor by a flexible shaft was a great source of noise. This camera drive was a development of talking picture equipment which the weight of the early motors made necessary, as it was not practical to hang much weight on the camera structure.

At this period each studio investigated camera silencing in its own way. By a process of experimentation and elimination, the present-day devices were evolved. They are by no means ideal and are being continually changed and improved. The generally accepted opinion is, of course, that the ultimate solution of this problem will depend on the development of a silent camera which it will not be necessary to enclose.

In camera booths, the natural development was along the lines adopted by most studios (with a few exceptions), that is, an individual camera enclosing box which, in its early stages, was simply a wooden framework covered with various sound insulating materials. This did not silence the camera sufficiently to permit its use within fifteen or twenty feet of a microphone and it was soon replaced by more efficient designs. It is unnecessary to follow the various stages of this development, but from a survey of the present-day equipment it is easy to see that it is simply an elaboration of this silencing box.

The new camera silencing devices became known as "blimps" or "bungalows." In the majority of cases the bungalow was made to contain the drive motor as well as the camera. Some of the studios adopted a form of drive motor which was mounted directly on the camera; others retained the flexible shaft but enclosed it inside the bungalow. One or two of the studios made separate bungalows for the motor and the camera, and covered the flexible shaft with heavy layers of sound insulating material.

The Fox Movietone Studios adopted as standard a camera bag composed of rubberized cloth, kapoc floss, and other soft insulating materials, fastened by means of zippers and snaps. The lens and finder protrude through the bag.

With the adoption of the heavy bungalow covered camera, a very much stronger and more rigid camera-tripod became necessary. The bungalows used by Warner Brothers and United Artists are light enough to mount on the standard tripod. Most of the other studios adopted either a tripod which was developed by Metro-Goldwyn-Mayer in collaboration with Pathé, or else an adaptation of this, used in conjunction with a standard tripod for rigidity.

The Academy of Motion Picture Arts and Sciences, under date of May 14, 1930, published through their Technical Digest Service, Report No. 3 of the Producers-Technicians Committee relating to camera silencing. This report gives in detail a complete résumé of all such devices in use at that time. It includes information on the insulating value in decibels, the methods of construction, materials used, and the distance that a microphone can be used from the camera.

Noiseless Recording Methods

The noiseless method of recording on film, announced at the end of 1930, appears to be receiving general acceptance throughout the industry. RCA Photophone has described two methods of effecting noiseless recording on variable width track. One of these displaces the zero line on the track in such a manner that the clear portion is only just wide enough to carry the modulation. This is subject to the disadvantage that weaving in the projector may cut off some of the weaker sounds. The second method uses a movable shutter during the recording which causes the clear part of the sound track to become blackened in those portions which are not employed to carry the modulation.

The Western Electric Company has announced a noiseless recording system which is applied to their variable density method. The density of the sound track is increased during the intervals in which the sound volume is low, and is decreased according to the envelope of the sound currents in such a manner that the film is always just able to accommodate the required modulation.

The Fox organization has devised a means for flashing lamp variable density recording, in which the intensity of the lamp is reduced during the intervals of low sound amplitude, the intensity being altered during the process of recording.

A number of independent makers of sound equipment, most of whom are using the flashing lamp, have announced attachments to their equipment which produce essentially similar effects.

The reduction of noise is accomplished during the actual recording by an attachment to the recording system, and, in general, involves no change in recording or processing technic. The amount of noise reduction which is being employed in most studios at the present time is of the order of 10 db.

Set and Studio Acoustics—Theatre Acoustics

Extensive investigations have been made by many interested in the factors concerned in set and studio acoustics and theatre acoustics. In some cases these studies have been made with recently developed instruments, permitting more accurate results than those previously obtained by aural methods. Several factors have been discovered by such means, some of which have contributed to the development of a more general formula for the computation of the time of reverberation. The application of this formula, which has been published by Dr. C. F. Eyring, of the Bell Telephone Laboratories, is of particular value in set and studio work, where average absorption coefficients are comparatively high. Important studies of the effect of relative humidity on sound absorption are being made.

The necessity for consideration of the reverberation existing throughout the frequency spectrum is now well appreciated. Whereas many enclosures had in the past been acoustically treated, giving consideration only to the reverberation at 512 cycles, experience in many of these cases indicates the necessity for obtaining suitable balance between the reverberation at the low and high ends of the frequency spectrum relative to that in the central portions of the range. It is becoming the practice to adjust theatres and recording studios to have times of reverberation throughout the frequency spectrum such as will give definite rates of decay for sounds of equal loudness. With the application of suitable accurate instruments for the measurement of reverberation times, studies have been made of the relative effects of connected volumes, which have an important bearing on complex auditoriums, as well as on recording sets on large stages. Further study, by instrumental means, has indicated the effect of direct reflection to be of importance and requiring consideration in the design of auditoriums, in addition to the consideration given the reverberation time.

The importance of maintaining a very low noise level has been extended to cover not only the studio, but the theatre. This has become more necessary with the development of recording methods insuring a lower background level in the sound picture. Attention must be given to the transmission of

noise from the projection room into the theatre, from the ventilating systems, from sources external to the auditorium, and to miscellaneous noise sources within the auditorium.

More information is available upon the acoustic power required to provide satisfactory sound volume in an auditorium. It is, therefore, possible to predict more accurately what effect the introduction of absorbing material into an auditorium will have upon the sound volume and, where necessary, upon the electrical requirements of the system.

Many improvements have been noted in existing commercial materials and a large number of new materials suitable for studio and theatre use have been developed and introduced in the past year. This has considerably widened the field for obtaining materials having the desired acoustic characteristics for the particular application and which will be more readily acceptable from the standpoints of architectural appearance, fire hazard, and cost.

Preservation of Sound Prints

The Committee has been fortunate in receiving from a firm prominent in the film industry the results of tests, conducted over a period of two years, of processes which purport to preserve motion picture film. The method used in these tests was to prepare loops of film, half of which were processed and half unprocessed, both sections being taken from the same reel or roll. These loops were projected 300 times, with examination at 100, 200, and 300 runnings, on a specially prepared projection machine, which caused as little wear as possible.

The processes tested were such as lacquer, surface hardening, whole surface waxing, chemical impregnation, liquid edge waxing, etc.

The noticeable effect of the processes investigated was that the film became seasoned more quickly, so that during the first few times of projection, the emulsion did not collect on the shoes and tracks of the projection machine as is often the case with green emulsion.

There was also indication from this set of tests that liquid edge waxing provides comparable protection. Once past this initial period, however, it was not evident that the processes provided any material improvement in giving greater lasting qualities to the film.

Talking Motion Picture Equipment for Home Use

In recent years several talking motion picture equipments have been developed and offered for sale for home use. Practically all of these equipments use a 16 mm. projector with either a flexible shaft or geared connection to a synchronous turntable for disc reproduction of sound. All the devices examined, except one, project 24 pictures per second and employ a turntable driven at 33⅓ r.p.m. This one exception projects 16 pictures per second and the projector and turntable are driven by electrically interlocked motors. In order to maintain synchronism with the 33⅓ r.p.m. turntable, every third frame is removed in printing from the negative to the positive.

At the present time 16 mm. films synchronized with sound are difficult to obtain and are expensive. If an extended library of films were available, it is probable that a larger demand would appear for home talking movies. To date, the supply of films is extremely limited and these films are available only in the larger centers, requiring personal application to obtain them and personal return. This mitigates against very extended use of these films and is a serious detriment toward obtaining a large market for the reproducing equipment in the home.

GLENN E. MARTIN
Progress Committee, S. M. P. E.

Talking Motion Picture Equipment for Non-Theatrical Uses

Considerable demand is apparent for talking motion picture equipment for non-theatrical uses, this equipment to be used either for advertising purposes, instruction work, in schools, churches, etc. Equipment for this purpose is built by all the leading talking motion picture apparatus manufacturers. The trend seems to be toward a 35 mm. film with sound on the film, although some equipment has been built with the idea of using 16 mm. film and a synchronized disc, which permits a picture of sufficient size and brilliance of illumination for small audiences. Libraries are being developed which will undoubtedly stimulate the exploitation of such equipment.

Sound Equipment in Theatres

On January 1, 1931, there were reported to be in the United States 13,515 theatres equipped for sound reproduction and 8,209 theatres unequipped. It might, therefore, appear that during the period of sound equipment installations only about 63 per cent were completed. Many of the theatres now running silent, however, are unprofitable houses which may never be able to afford sound equipment. With the decreasing number of silent picture releases, these theatres may be forced to close. It follows, then, that the installation period is well over 63 per cent completed. Perhaps 80 per cent would not be too high a figure.

It may be considered that the industry is passing out of the installation period and is now entering a period of stability in operation and of refinement. The novelty value of sound has passed with every indication that sound has become as necessary a factor in the theatre as is the picture on the screen.

The first problem of theatre projection is obviously to keep a picture on the screen and to maintain sound from the horns. It so happens that statistics from Electrical Research Products, Inc., are available, which show the ratio of emergency calls to theatre installations in the United States over a period of time. In December, 1928, with roughly a thousand theatres equipped, the ratio of emergency calls per week to theatres in service was about 0.185. In December, 1929, with 3300 theatres equipped, the ratio had fallen to about 0.05. In December, 1930, when nearly 5,000 theatres were equipped, the ratio was as low as 0.022. This decrease in emergency calls is caused by improvements in design and manufacture, and to proper and continued maintenance of the equipment. It is logical to believe that the operating troubles experienced with other reputable systems follow somewhat the same general course. It is consequently obvious that the first requirement of sound projection, namely, consistent and reliable operation, has been achieved. The quality of sound now focuses our attention.

Poor theatre acoustics constitutes one of the most serious causes of poor sound reproduction in theatres. Acoustic analyses have been made in a large number of theatres and corrections of the conditions have been made in some cases. It often happens that the theatres less able financially to make the correction need it most. It has been proved in so many cases that improved acoustic conditions result in increased

(*Continued on page 22*)

Nitrocellulose motion picture film

The regulations of the National Fire Protection Association for the handling and storage of motion picture film, as here presented, have been voted upon affirmatively by a majority of the association's committee covering this subject.

THE Fire Underwriters' rules and their application, follow:

1. Application of rules. These regulations are intended to apply to the storage and handling of nitrocellulose motion picture film, in all places except establishments manufacturing such film and storage incident thereto. They are not intended to apply to the storage and handling of film having a cellulose acetate or other approved slow-burning base nor to photographic and X-ray film. (See separate regulations on Photographic and X-ray Film.)

2. Scope of regulations. (a) These regulations are intended to provide reasonable provisions for the storage and handling of motion picture film, based on minimum requirements for safety to life and property from fire.

(b) The intensity of heat and rapidity of combustion of burning film are such that it is highly preferable that occupancies, such as film exchanges, laboratories and studios, be permitted only in sprinkled buildings of fire-resistive construction. In many sections of the country buildings of inferior construction have been adapted to such occupancies, under which circumstances it is essential that proper consideration be given to protective devices, such as automatic sprinklers; and that all vertical openings, between floors, as elevator and stair shafts, be fully enclosed, and that adequate exit facilities be provided. Such features are most essential from the safety to life standpoint. These regulations are based on the assumption that such features are properly taken care of by building ordinances. Suitable requirements will be found in the Recommended Building Code of the National Board of Fire Underwriters.

3. Arrangement of regulations. (a) These regulations are divided into two parts: Part I gives general provisions regarding the storage and handling of film; Part II gives special provisions for special occupancies as motion picture theatres, exchanges, laboratories, and studios, which apply in addition to any and all of the general provisions which may also be applicable.

(b) The grouping of the special provisions under the heading of special occupancies is merely for convenience in the application of these regulations. Any particular process or operation in any type of occupancy shall be governed by the provisions given for that process or operation, whether under the heading of that occupancy or any other heading, unless otherwise specifically provided herein. For example, any process in a studio which, from the standpoint of the authority enforcing these regulations, partakes of the same nature as some process covered under laboratories, shall be governed by the provisions for that process given under laboratories.

4. Approval of plans. Before constructing any building for use as a motion picture film occupancy, or remodeling any building for such occupancy, or building any film vault, or installing any motion picture projection booth or screening room, complete plans of such proposed construction or installation shall be submitted to the inspection department having jurisdiction for approval. These plans shall show in detail all proposed construction and structural changes and the means of protection to be provided, the heating system with the protection for it, the electrical equipment, and the character and location of all exposures.

5. Definitions. Whenever used in these regulations the following words shall be construed as having the meanings given below.

(a) "Film" or "motion picture film," motion picture or sound recording film having a nitrocellulose base, whether in the form of unexposed film, positives, negatives, scrap, or used film.

(b) "Vault," a vault constructed and equipped in accordance with the requirements of Section 17.

(c) "Cabinet," a cabinet constructed and equipped in accordance with the requirements of Section 16.

(d) "Standard roll," a roll of film 1⅜ inches (35 mm.) wide and 1000 feet long, weighing approximately 5 pounds, used as a unit in calculating the weight of film.

Note: The weight per 1000 feet, of 70 mm. and other widths of film will vary approximately as the width.

(c) "Partition," except where some other form of construction is specified, a partition constructed in accordance with the specifications given in subsection 112.

Part I. General Provisions Regarding the Storage and Handling of Motion Picture Film.

Section 11. Construction and Arrangement of Buildings

111. Motion picture film should preferably be stored or handled only in buildings of fire-resistive construction.

112. Partitions. (a) All rooms in which motion picture film is stored or handled, except motion picture projection booths and film vaults, shall be separated from each other and from all other parts of the building by partitions of suitable stability and having a fire retardant classification of not less than 1 hour as determined by the Standard Fire Test. Partitions constructed as follows shall be deemed to have the required fire retardant classification:

(1) Hollow clay tile laid in cement mortar, cement lime mortar or gypsum mortar, not less than 4 inches thick and plastered on both sides with not less than ½ inch of gypsum mortar or cement mortar;

(2) Gypsum blocks, either solid or hollow, laid in gypsum mortar, not less than 3 inches thick and plastered on both sides with not less than ½ inch of gypsum mortar;

(3) Metal lath supported by incombustible studs, plastered on both sides to fully cover the metal lath and studs with not less than ¾ inch of gypsum mortar or cement mortar and having a total thickness of not less than 2½ inches;

(4) Wood studs covered both sides with metal lath and ¾ inch gypsum mortar or cement mortar, and having a total thickness of not less than 5¼ inches. (This type of construction to

be used only in buildings not of fire-resistive construction.)

(b) Partitions shall be continuous from floor to ceiling and securely anchored to walls, floor and ceiling.

(c) Openings in partitions shall be protected by approved fire doors of a type suitable for use in Class C situations as defined in the Regulations for the Protection of Openings in Walls and Partitions Against Fire.

113. Exits. It is essential that all rooms in which film is handled be provided with adequate aisle space and safe means of egress. Rooms in which film is handled and in which more than two persons work shall have two or more exits, remote from each other. Every exit shall be marked "Exit" in letters not less than 6 inches high, or by an illuminated sign with letters of the same height.

114. Vents. All new buildings erected to be used as, and all existing buildings remodelled for film occupancies shall be provided in every room where film is to be stored or handled, with vents which will open automatically in case of fire. These should be of ample size; they may be in the form of automatic skylights or automatic-opening window sash. All rooms in which film is stored or handled in existing buildings shall be provided with such vents wherever practicable.

115. Spacing of workers. A feature which often contributes materially to the hazard to life in film handling rooms is the congestion of workers together with large quantities of film. To prevent such congestion of workers and the attendant hazard to life, the number of persons working in a room where film is handled should never be more than will result in a ratio of floor area to number of workers, less than 35 square feet per person. Not over 15 persons shall work at one time in any one room (not including the stage of motion picture studios) in which film is handled.

116. Tables and racks. Tables and racks used in connection with the handling of film (joining, inspection and assembling tables for example) shall be of metal or other non-combustible material. They should be kept at least 4 inches away from any radiator or heating apparatus. Tables shall not be provided with racks or shelves underneath them, which might be used for keeping film or other materials.

Section 12. Electrical Equipment

121. Artificial illumination in any room where film is handled or stored shall be restricted to incandescent electric lights, except that arc lights or other forms of electric lights may be used in studios.

122. All electrical wiring and equipment shall conform to the National Electric Code. Wiring shall be in metal conduit, and fuses shall be enclosed.

123. Light fixtures shall be firmly fixed in place and lights shall be protected by vapor-proof globes. All lights shall be equipped with keyless sockets and operated by wall switches.

124. Light boxes reading "EXIT" in letters not less than six inches in height shall be placed at the exits of all dark rooms.

125. Portable electric lights on extension cords are prohibited in any room (not including the stage of motion picture studios) in which film is handled or stored.

126. Motors shall be of the non-sparking type, or shall be of an enclosed type, so arranged as to minimize the danger of sparks.

127. Motion picture projectors shall be of an approved type and safeguarded in accordance with the requirements of the National Electrical Code, Article 35.

Section 13. Heating Equipment

131. Artificial heating in any building or room, other than a vault, in which motion picture film is used, handled or stored, shall be restricted to steam not exceeding 10 pounds pressure or hot water, provided however, that this shall not be construed as prohibiting the installation of an indirect system employing high pressure steam when the radiators or heating coils of such system are not located in the room or rooms to be heated. Heat generating apparatus shall be in separate room.

FROM the life standpoint a fire having only a small property loss may be as disastrous as one involving considerable damage. A gruesome tragedy is all too likely to occur when a fire breaks out in a theatre during a performance. Even a small fire, with a crowded auditorium and panic, assumes tremendous proportions.

Note: Ordinary hot air furnaces are prohibited. Gas, oil and electric heaters are prohibited in rooms where film is handled or stored.

132. All steam pipes within 6 feet of the floor, and where passing through partitions or racks or near woodwork, shall be covered with approved pipe covering. All radiators, heating coils, and pipes and returns that are near the floor or are so located as to permit any combustible material, waste or dirt to come in contact therewith shall be guarded and perfected by means of ¼-inch mesh galvanized steel wire cloth No. 20 B. & S. Gauge, or by its equivalent. The bottom of such guards shall be arranged so as to lift up for cleaning purposes and the tops to slope so that guards cannot be used as shelves. Guards shall be so constructed that no film can come within 4 inches of the heating surface, and shall be made with a substantial metal framework which will prevent the wire mesh being forced against the radiator or pipes.

Section 14. Sprinklers and Other Fire Protection Appliances

141. Every room in which film is stored or handled in quantities greater than 50 pounds (10 standard rolls), except in motion picture projection booths or rooms and rewinding rooms connected therewith, shall be equipped with an approved system of automatic sprinklers. Buildings or sections of buildings used as exchanges, laboratories or studios shall be equipped with automatic sprinklers, as provided under subsections 221, 231 and 241. All buildings used for the storage or handling of film should be completely equipped with automatic sprinklers.

142. The spacing of sprinkler heads in all sections where film is handled shall not exceed one head for each 64 square feet, with heads and lines not over 8 feet apart; provided that in the stage section of motion picture studios the spacing of sprinklers shall not exceed one head for each 80 square feet. In existing buildings where the spacing of sprinkler heads exceeds that specified above, the inspection department having jurisdiction may require the installation of additional heads wherever the hazard of some machine, process, or accumulation of film warrants such protection.

143. (a) It is recommended that two independent sources of water supply be provided, acceptable to the inspection department having jurisdiction.

(b) Water supplies for automatic sprinklers shall be based on an estimate of 20 gallons a minute per head for 20 minutes for the total number of heads in one vault, plus 25 per cent of the number of heads in the largest fire area. (A fire area is regarded as an area cut off by brick or concrete walls having a minimum thickness of 8 inches; each opening in these walls to be protected by one self closing fire door, Class A type.)

(c) Where gravity tanks form the primary source of supply they shall be elevated at least fifty feet above top sprinklers. Minimum capacity of gravity tanks shall be 10,000 gallons.

(d) Due to alterations and resulting impairments customary in plants of this type sprinkler equipments shall be so arranged by the introduction of floor and auxiliary control valves, that maximum protection can be maintained at all times.

144. Every room in which film is

stored or handled except film vaults, shall be provided with first aid fire appliances of types using water or water solutions.

Note: Small hose equipment is recommended, and the following types of extinguishers are considered suitable: Soda acid, calcium chloride, pump tank, water pails and loaded stream.

Section 15. Storage of Film

151. The storage of motion picture film, having reference to amounts of film accumulated or laid by for disposal or use at some later time, as a few hours or longer, shall be in accordance with the following rules:

(a) Except as hereinafter provided in paragraph (b),—

(1) Amounts in excess of 25 pounds (5 standard rolls) but not in excess of 1000 pounds (200 standard rolls) shall be kept in approved cabinets if not in vaults;

(2) Amounts in excess of 1000 pounds shall be kept in vaults.

(3) Storage for any considerable length of time should be in vaults only.

(b) Unexposed film enclosed in the original shipping cases, conforming to I.C.C. regulations with each roll in a separate container, shall be kept in a sprinklered room, and if over 5 cases aggregating in excess of 750 lbs. (150 standard rolls) shall be kept in a sprinklered room used for no other purpose.

152. Valuable negatives shall be stored in vaults used only for such film, in suitable heat-insulating containers designed to minimize water damage.

Note: The above paragraph being principally concerned with safe-guarding values would not need to be inserted in an ordinance.

Section 16. Film Cabinets

161. Construction. (a) Cabinets including doors shall be of approved insulated construction.

Note: Cabinets may be of insulated metal construction, or may be built into the building with a type of construction listed under partitions, sub-section 112 (a) 1, 2 or 3, if otherwise conforming to the provisions of this section.

(b) Cabinets shall have a capacity of not in excess of 375 pounds of film (75 standard rolls).

(c) Racks in the cabinet shall be of metal and so arranged that containers will be stored on edge only.

(d) Doors shall close tightly against the jambs, and should be so arranged as to remain normally closed and latched.

162. Vents. (a) Cabinets having a capacity of over 50 pounds of film (10 standard rolls) shall be provided with a vent from each compartment to the outside of the building. The vent shall have a minimum effective sectional area of 14 square inches per 100 pounds of film capacity. For long lengths of vent pipe a larger size may be necessary to take care of friction loss and turns in the pipe.

(b) Vent flues shall be of construction equivalent to 18 U. S. gauge riveted sheet metal, and where inside the building shall be covered with 1 inch of approved heat insulating material.

163. Sprinklers (a) Cabinets holding over 75 pounds of film (15 standard rolls) shall be provided with at least one automatic sprinkler; provided, however, that a cabinet constructed so that each roll is in a separate compartment and will burn out without communicating fire to film in any other compartment, need not be provided with an automatic sprinkler.

(b) Cabinets of not over 125 pounds capacity for use in projection booths and rewinding rooms only, may have the required sprinkler head connected to the house supply by not less than ¾-inch pipe, provided the water pressure at that elevation be not less than 15 pounds, and is sufficient to supply not less than 15 gallons a minute.

DESPITE consistent attention to the reduction of fire hazards in theatres, fires continue. According to reliable statistics, fires in theatres occur at the rate of six to seven hundred per year in the United States alone, involving a loss of more than a million dollars.

164. Film in cabinets shall be in individual roll containers or in I.C.C. shipping containers. Materials other than film shall not be stored in the same cabinet with film.

Section 17. Film Vaults

171. Construction. (a) Vaults shall be constructed in accordance with plans submitted to and approved by the inspection department having jurisdiction.

(b) Vaults shall not exceed 750 cubic feet in inside dimensions.

(c) Walls and floor shall be constructed of not less than 8 inches of brick, 6 inches of reinforced concrete, or of 12 inches of hollow tile plastered on both sides with cement plaster to a thickness of at least ½-inch; they shall be without cracks or holes permitting escape of gases of combustion into the building.

(d) Vaults shall be supported by masonry or steel of sufficient strength to carry the load safely. Beams shall rest at both ends on steel girders, iron or steel columns or walls or piers of masonry. The supports shall afford at least 4 hours' protection as determined by the Standard Fire Test. Hollow tile shall not be used for foundation walls or for walls of other than the top vault where vaults are superimposed.

(e) The roof shall be an independent, reinforced concrete roof at least 6 inches thick; where the floor or roof above is equivalent to this, it may serve as the vault roof; a heavy wire screen of not less than 2 inch mesh, or its equivalent may be installed below the required roof to limit the interior vault space to 750 cubic feet.

(f) Unless the building is designed to safely sustain the load resulting from the vault being filled with water, the vault shall be provided with suitable drains or scuppers to the outside of the building.

Note: A depth of 10 feet of water will result in a floor load of 625 pounds per square foot.

(g) Proximity to stacks and other sources of heat shall be avoided.

172. Doors. Door openings shall be protected with approved fire doors, one on each face of the wall.

Note: Vaults may have two door openings. Such an arrangement is often a great convenience, as in laboratories, where the vault is located between rooms and used for the temporary storage of film in process.

Doors shall be of the type suitable for use in Class B situations as defined in the Regulations for the Protection of Openings in Walls and Partitions Against Fire. The interior door shall be automatic. The outer door shall be of the swinging type and close into an approved frame or otherwise made tight to prevent the passage of flame around the edges. It shall be self-closing, and if fastened open shall be arranged to close automatically in case of fire originating in or out of the vault. Approved quick-operating devices for closing vault doors are recognized as having advantages over the fusible link, and their use is recommended.

173. Vents. (a) Each vault shall be provided with an independent vent having a minimum effective sectional area of 140 square inches per 1000 pounds of film capacity (equivalent to 70 square inches per 100 standard rolls). The vent area for a vault of 750 cubic feet shall be not less than 1400 square inches.

Note: In determining the proper vent opening, allowance must be made for the window frame and sash, for the area of the glass is considered the effective sectional area of the vent opening.

(b) Vent flues inside the building shall be constructed of 5 inches of reinforced concrete or of a construction equivalent to that required for smoke

chimneys. Exterior flues shall be of a construction equivalent to that of smoke stacks.

(c) The outlet of each vent shall be above roof or shall be made to face street, court or other clear opening which will give a distance of at least 50 feet to any window or other opening exposed thereby and not in the same plane, and a distance of at least 25 feet to any fire escape on the same or higher level.

(d) Vaults, especially those having a vent in the form of a window, shall be arranged in some manner which will protect the film in the vault against ignition by,—

(1) Rays of the sun, whenever the film in the vault is exposed to direct rays of the sun entering through the vent. This may be done by painting the glass in the vent opening a dark color;

(2) Radiated heat entering through the vent opening, as from an exposure fire, whenever the vent is severely exposed by buildings or storage of combustible material, or by other openings in the same wall.

To effect the above protection one method which has been used employs two baffle walls inside the vault. The baffle wall nearer the vent should extend from the ceiling down to within about 3 feet of the floor, and the inner baffle wall from the floor up to within about 3 feet of the ceiling. Baffle walls should be of substantial construction and should be so spaced and arranged as to afford the full required vent area from the film storage space to the outside.

(e) Each vent shall be protected against the weather by single thickness glass (1-16 inch thick, in a sash arranged to open automatically in case of fire by the means of an approved releasing device placed inside the vault. The use of approved quick operating devices is recommended. The area of the glass shall be the effective sectional area of the vent opening. No pane of glass shall be smaller than 200 square inches. Any protection equivalent to the above may be accepted in lieu thereof.

(f) A light wire screen not coarser than ⅛-inch mesh shall be placed in each vent. Bars or screen designed to prevent burglary or injury to contents shall not have a mesh of less than 4 inches, shall be located inside the light wire screen, and shall give a net opening equal to that called for under vents. Bars and screens shall be so arranged as not to interfere with the automatic operation of the sash.

(g) Film vaults shall not be provided with skylights or glass windows other than as specified under vents.

174. Racks. Racks in film vaults shall be of metal or other incombustible material and arranged for the storage of single reel containers on edge or for I. C. C. shipping containers. Vertical incombustible partitions equivalent in durability and heat insulation to ⅜-inch hard asbestos and extending from floor to top of rack shall be provided to divide racks into sections not over 3 feet wide and so placed as not to obstruct distribution from sprinkler heads. Racks shall not obstruct vent openings.

175. Sprinklers. Vaults shall be protected by an approved system of automatic sprinklers, with a ratio of one head to each 62.5 cubic feet of total vault space. A vault of 750 cubic feet shall have 12 sprinkler heads. Sprinkler heads shall be arranged to give uniform distribution within the sections formed by the above mentioned partitions. They shall be separated by sheet-metal baffles extending below the sprinkler deflectors. When an approved automatic sprinkler system with open heads is permitted by the inspection department having jurisdiction, the baffles between heads may be omitted.

176. Lights. All lights in film vaults shall be at the ceiling and of the fixed type, with vapor-proof globes and conduit wiring. All switches shall be outside the vault and should be arranged with a small pilot light to indicate on outside of vault whether vault lights are on or off.

177. Heat. Heating, when required to prevent sprinkler pipes freezing, shall be by hot water or low-pressure steam with automatic control limiting steam pressure to 10 pounds and the vault temperature to not in excess of 70° F. Radiators shall be placed at the ceiling, over aisle space with pipes and radiators protected with wire guards so arranged that no film can be placed within 12 inches of such pipes or radiators.

178. All film in vault shall be in containers, either in single-roll containers which shall be kept on edge on racks only, or in I. C. C. shipping containers which may be kept on the floor. Materials other than film and film cement shall not be stored in the vault.

Section 18. Handling of Film

181. Film shall be in containers. All film shall be kept in closed containers except during the actual time it is being worked upon or examined. This is very essential from the standpoint of fire hazard and safety to life. I. C. C. shipping containers and individual containers for each roll of film with proper corrugations on each side are recommended.

182. Film shall not be placed or kept under benches, tables, or other surfaces which would shield it from the discharge of sprinklers.

183. Motion picture film in the form of clippings and short lengths is in a very hazardous form. Safe precautions in the handling of such scraps is most essential. Scrap film shall be kept separate from waste paper and other rubbish, and shall be kept under water at all times. It should be collected from work rooms at least once daily, and removed to a room used for no other purpose, where it shall be kept under water in steel drums with tight covers. These drums shall be disposed of at frequent intervals. Discarded film in full or part rolls shall be kept in vaults. Scrap film shall not be baled or burned.

Note: Baling and burning of film are processes offering a distinct fire hazard. Sending film to a central reclaiming plant in lieu of burning is recommended.

184. Transportation. (a) Motion picture film should never be transported in any vehicle or other public conveyance used for the transportation of passengers, unless enclosed in I. C. C. shipping containers.

(b) Motion picture film should never be allowed in any underground subway train or station unless under the jurisdiction of the Interstate Commerce Commission and conforming to the regulations thereof.

(To be continued)

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A simple cine-photomicrographic apparatus

A paper on the above subject by Arthur C. Hardy and O. W. Pineo was presented at the recent Hollywood convention of the S. M. P. E. The paper describes a simple cine-photomicrographic apparatus built for the Bio-Cinema Research Laboratory at the Massachusetts Institute of Technology. The essential feature of the apparatus is an optical system which permits the separation of the microscope and illuminating system from the camera and its driving mechanism. The microscopist is thus enabled to use the microscope in the ordinary manner for visual work and has merely to insert the unit under the camera when the subject is ready to be photographed. In this way the same camera can be used interchangeably with a number of microscopes.

Glass Theatres

ACCORDING to the *Cinematograph Times,* London, in the July issue of *The Builder,* E. G. Warland, A.I., Struct.E., writes interestingly upon "The Walls of Tomorrow," and deals with the possibilities of glass and other translucent material. He visualizes, and illustrates his article with a drawing of the super-theatre of 1933, the main elevation of which is worked out in broad bands of glass, illuminated from behind and providing a very striking background for publicity material.

"I visualize," he says, "before long for certain classes of buildings that we shall have a lighter steel-skeleton framing. To this will be fixed sheets of glass, or other thin material, for the external face, and on the inside will be fixed sheets of reinforced plaster, cork slabs, asbestos-cement sheets, or clay blocks. The void between these two skins, which will form permanent shuttering, can then be filled with concrete. . . . I think of the possibilities of this new method; imagine a glass-fronted theatre, faced in, say, blue and orange glass and lighted up in bands of color and light from behind. Obviously there is scope here for original and striking design—a cheap, effective and easily cleaned façade. I can only hope that those who step in and take advantage of this opportunity will prove themselves worthy of it, and not produce something merely novel and gimcrack."

That so far-seeing an engineer as Mr. Warland should visualize the coming of a new and attractive type of picture is likely to meet with greater interest at this juncture, when variation of the USUAL types seems to have reached something approximately the margin of limit. Two well-known and experienced technical men, John Wilson, chief engineer of the Gramo-Radio Company, Accrington; makers of the typical theatre horns and loudspeakers, and C. Hartley-Davies, S.M.P.E., B.K.S., seem, however, to have pre-visualized the possibilities of cavity wall construction internally illuminated last year.

They put their idea to the practical test of application for patents in their joint names.

This invention related to illuminated walls by cavity lighting and heating, and has for its object the reduction of the gross weight of high buildings, and the lowering of building costs, while providing permanent and ornamental decoration. It consists essentially of a building, the skeleton of which is of steel and the outer shell of known building materials. The inner walls of such building, however, are not made from the known building materials ordinarily used for the construction and decoration of interiors, but from marble, glass, or any other transparent or translucent material, leaving a cavity behind the facing material and between the steel stanchions forming the upright supports of the building for electric lighting and heating. By the use of mirrors and prisms in the cavities various lighting effects are obtained.

Where desirable, not only the inner, but also the outer walls, are made from the transparent or translucent materials already mentioned in preference to the known building materials, and such exterior walls are also provided with cavities behind for electric lighting and heating. Where exterior walls are constructed in this manner, and in particular frontages, brilliant effects are obtained at night.

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DE FOREST PLANS TO REPLACE 1,000 DEVICES IN 6 MONTHS

UNDER its new replacement plan, General Talking Pictures expects to make approximately 1,000 installations of De Forest equipment during the next six months. Theatres having De Forest devices are being offered replacement of more up-to-date equipment under a rebate arrangement. Forty of these replacements have been effected since the new plan was placed in operation, it is stated.

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ADJUSTMENTS FOR LIGHT VALVE RECORDING

(*Concluded from page* 10)

in correlation with the filament current producing this effect. This value will then be employed for all recording work with this particular lamp.

A rougher method is possible if another lamp previously calibrated is on hand. Suppose for instance we have a recorder lamp known to give correct exposure when the filament current is 15 amperes. With this lamp in position an oscillator is patched to the light valve and the photoelectric cell internal to the recording machine is coupled through the amplifiers to an indicator. The oscillator having been set to, say, 1,000 cycles, attenuators are adjusted so that a mid reading appears on the meter. The recording lamp is then removed and the new and untried unit slipped in its place. The filament current is then adjusted so that it gives the same reading. It is better to check several frequencies, as in practice it is sometimes found that recording lamps do not always follow a straight line curve as regards actinic effect at different frequencies.

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MADISON SQUARE GARDEN TAKES THE SOUND CURE

(*Concluded from page* 14)

engineers of Acoustic Consulting Service of the Electrical Research Products Co. The result is a new ceiling considerably lower than the old one and still high enough to allow the circus trapeze artist all the movement she needs or to permit a gridiron star to punt his highest if night football ever becomes an innovation at the Garden, and the acoustic improvement has borne out the accuracy of the findings.

It was estimated in the preliminary survey that as a result of such treatment the reverberation time would be reduced to a value of from 3.5 seconds when the hall was empty to 1.56 seconds with an audience of 18,000.

Tests made under the new conditions proved these figures to be correct.

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SOUND PROJECTION PRACTICE

(*Continued from page* 17)

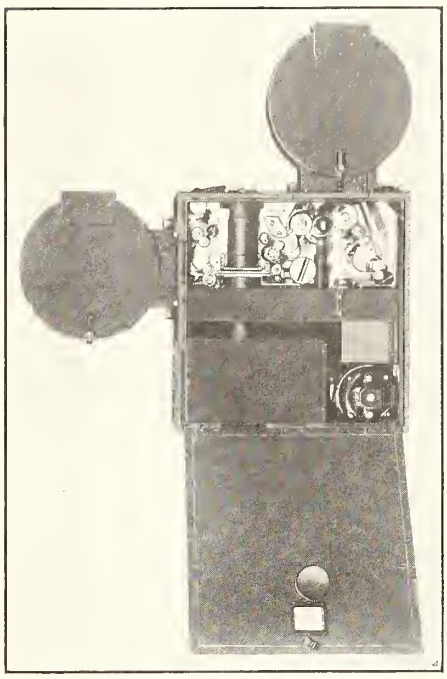
box-office returns that the expense of the change has been thoroughly justified. It is believed and hoped that more theatres can avail themselves of this improved condition not only for their own salvation but to give to the public all the benefits of the improved products which could not otherwise be realized.

There has probably been a healthy although unconscious competition between the studio and the theatre in striving toward higher quality. Such improvements as better reproducers for disc records, finer optical systems, and smoother mechanical features for film reproduction, along with other general advances applicable to both methods, have raised the standards of the theatre equipment to the point where they are capable of handling good quality recordings. Improved technic in the studios, resulting from such factors as study of stage and set acoustics, microphone placement, better knowledge of re-recording methods, and more exact control of film processing, have made it possible for the studios to show a tremendous improvement in the quality of the recorded product.

The gradual extension of the frequency range has been a material contribution to this improved quality but efforts toward a greater range should be and are being continued.

(*To be concluded*)

A new, dependable, low cost portable sound unit



The new RCA-Photophone portable projector as it appears when opened.

AFTER more than a year of intensive research and development, RCA Photophone, Inc., announces the production of an entirely new portable sound reproducing unit and has begun its manufacture on a large scale. Designed primarily to meet the ever-increasing demands in the fields of education and industry, the new apparatus has been constructed to serve in any capacity where portable sound reproducing equipment can be employed to best advantage.

The entire unit comprises a projection machine, an amplifier, a loudspeaker and a carry-case for film, and these have an aggregate weight of slightly more than 200 pounds. The projection machine is 19 inches high, 19 inches wide and its breadth is 10 inches. The amplifier, which is built in a carry-case having a removable cover, is 26 inches long, 8¾ inches high and 11 inches in breadth. The loudspeaker, which is of the flat baffle type, is contained in a carry-case, the dimensions of which are 8½ x 19 x 14½ inches.

RCA-Photophone loudspeaker as adjusted for operation.

Standard 35 mm. film is used and adequate sound reproduction is obtainable in a room or hall having a content of 75,000 cubic feet when using the 8-inch directional baffle. A 6-inch dynamic cone speaker is supplied when the cubic content of the auditorium does not exceed 12,000 feet. A picture about 8 x 10 feet in dimensions is obtained upon the screen from a throw of 75 feet. The equipment is a-c. operated from an outlet of 105 to 125 volts, either 50 or 60 cycles, single phase power source. The total power required is approximately 12 amperes at 100 volts.

Connections between the various units are made by means of suitable cables fitted with the necessary plugs and receptacles. For a complete setup using one projector, only four cables are required. One is for the power supply to the projection machine; one for the power supply to the amplifier which may be plugged into a receptacle in the projector; one to connect the signal circuit of the projector to the amplifier and one from the amplifier to the loudspeaker.

The projector is designed to accommodate a one-thousand foot standard reel, a Standard Series I theatre projection lens with limits of focal lengths of 3¾ inches to 8 inches, a one-thousand watt, 110 volt, pre-focused base projection lamp, a 10 volt, 7½ ampere exciter lamp and a UX868 photoelectric cell.

In announcing the new portable, E. O. Heyl, vice-president and general sales manager of RCA Photophne stated:

"We believe our engineers, in collaboration with the engineering department of the RCA Victor Company, have produced a portable sound reproducing unit of exceptional merit. More than a year's time was consumed in research and experimentation before our engineers had obtained the results toward which they had been aiming.

"They had been asked to develop and perfect an apparatus that would measure up to the high standard of efficiency that has been maintained by our other types of sound reproducing equipment and, if possible, to produce it at a cost which would make it possible for us to place it on the market at a price that would be attractive. This has been accomplished. The new RCA Photophone portable sound reproducing unit is now in what might be characterized as the 'popular price' class. It is well within the means of any college, university, school, church, fraternal organization or any non-theatrical institution that heretofore has employed silent motion pictures for education or entertainment purposes.

"The constantly increasing interest by industrial leaders in sound motion pictures was a factor which prompted us to place this new machine upon the market. Manufacturers of nationally and internationally advertised products are begininng to see the tremendous possibilities of the sound motion picture as an adjunct to extensive newspaper and magazine advertising campaigns. Already a number of cleverly conceived advertising sound motion pictures have been made and presented with exceedingly satisfactory results in various sections of the country. It is our firm belief that the sound motion picture will be an important factor in connection with future developments in education and industry."

It is understood that RCA Photophone, Inc., will employ dealer distribution along with its own selling organization in introducing its new portable apparatus.

New Developments and News of the Industry

ELECTRAD AMPLIFIERS

When measured by the multiplicity of its uses and advantages, no other development of modern times compares with the power amplifier. First produced as a radio accessory, it has outgrown radio by leaps and bounds, and now occupies a distinct field of its own. Wherever sizable audiences must be reached, wherever widely distributed oral communications or musical entertainment are desired, the power-amplifier, with its accessory equipment, wipes out distance and provides the outlying listeners with a front-row seat. Electrad amplifiers are distinctive because of their simplicity, compactness, higher gain and great distortionless output with a minimum of input voltage. The Loftin-White direct-coupled circuit is used, which requires fewer parts and yet performs more efficiently, with finer quality of reproduction.

Electrad, Inc., 175 Varick Street, New York, has a new bulletin describing this new line.

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CARBON SAVINGS

Examine the stubs in the carbon waste can in your projection room! Compare them with a full length carbon! Then look at your carbon bill! Each stub can be burned down to a two inch stub with the GoldE 30 per cent carbon saver.

The projectionist merely inserts the burnt end of the carbon stub in the saver, twists it into the taper, self tightening thread, locks it with the anchor screw, rolls on a flat surface for trueing.

When carbon burning time is noted the stubs can be so graded as to make their use economical to the last degree.

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NEW DISC RECORDS

A new method of recording by means of which twice as much music can be put on a phonograph disc as formerly was announced in August by the Durium Products Corporation. Described as the greatest development in recording since the introduction of the electrical system, the new process, known as the Micro-Channel process, will permit the playing of an entire piece of concert music without touching the phonograph to change the record.

The improvement is effected by reducing the thickness of the walls between the needle grooves. Records manufactured by this method are made of Durium, a synthetic resin which is extremely tough and at the same time flexible. Special fibre board is coated with a shell of Durium five one-thousandths of an inch thick, on which the recording is made. The finished record can be scaled across the room, placed flat on the floor and hammered, or bent almost without injury.

Because of the durability of Durium, the needle grooves are placed very close together, with twice as many grooves or channels to the inch as in ordinary records. Exhaustive tests show that notwithstanding the reduced wall thickness they can be played about three times as often as the old-style record.

The first commercial application of the new method will be a standard-sized disc containing five minutes of music, or twice the capacity of the ordinary record.

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DUBILIER TUBULAR PAPER CONDENSERS

In keeping with the trend towards individual condensers inserted in the point-to-point wiring, in place of expensive condenser blocks in cans, the Dubilier Condenser Corporation, 4377 Bronx Boulevard, New York City, announces a new line of tubular paper condensers.

The Dubilier Type 706 is an outside wound or non-inductive standard paper section wound on the standard mandrel and surrounded by several turns of heavy craft paper. Pigtail leads permit of ready wiring in any circuit. The tightly wound paper covering provides ample mechanical and dielectric strength. An attractive label is printed on the paper wrapping.

Among the outstanding features of the new unit are extreme compactness and convenience. The unit represents solid condenser in the absence of a can or container. Due to thorough impregnation of

the completely wound section and its cover, together with the special means whereby the paper wrapping shrinks tightly over the section, the resultant unit is fully protected against moisture and mechanical effects. The leads are securely held in place and cannot be pulled loose without destroying the condenser. The ends are fully insulated, so that only the leads themselves present "live" parts.

Dubilier 706 units are available in various capacities from .0001 to ½ mfd., and in d-c. working voltages from 200 to 600 volts.

CRYSTAL CUTTING HEAD

A cutting head particularly suited for recording metal records is announced by the Astatic Microphone Laboratory, Youngstown, O. The cutter uses a Rochelle Salts crystal as the driving element. The frequency response of the cutter is unusual, increasing with frequency. Almost any desired response may be obtained by simple electrical networks. The impedance of the cutter is quite high and may be coupled directly to the plate of the power tube without matching. The action of the crystal in the circuit is much the same as a good condenser. Other applications of these crystals include microphones, phonograph pickups, loudspeakers and as driving elements in oscillographs.

▲

CELL COUPLING CABLE

G-M Laboratories, Inc., 1735 Belmont Ave., Chicago, announce the perfection of a new cell coupling cable for use in sound equipment. This cable has five times the capacity reactance of standard microphone cable so frequently used in sound equipment, and in addition, is highly non-microphonic.

The use of this cable reduces the attenuation of high frequencies, eliminating to a large degree the frequency discrimination of most photoelectric cell amplifiers. This results in increased brilliance of reproduction of voice and instrumental music, so noticeably lacking in many types of sound equipment.

Those interested in this cable may obtain information by asking for G-M bulletin No. 134.

▲

RCA-PHOTOPHONE, INC.

With the initial manufacturing order for 500 units of special size sound reproducing equipment being rapidly absorbed by the unprecedented demand from exhibitors in both domestic and foreign fields, E. O. Heyl, vice-president and general sales manager of RCA Photophone, Inc., announces a duplication of the first manufacturing order to take care of the requirements of the commercial and foreign departments for the remainder of the year.

"We had no idea that our initial order would be absorbed so quickly," said Mr. Heyl, "but immediately after we announced the introduction of our new all a-c. operated special size equipment for theatres up to 500 seating capacity, the response was quite surprising. While we are making installations in many new theatres and in some that had not as yet given up their silent apparatus, the majority of our installations are replacements. The small exhibitor realizes that he no longer can attract patrons to his theatre unless he can guarantee satsfactory sound and our new special size apparatus is designed expressly to meet his requirements."

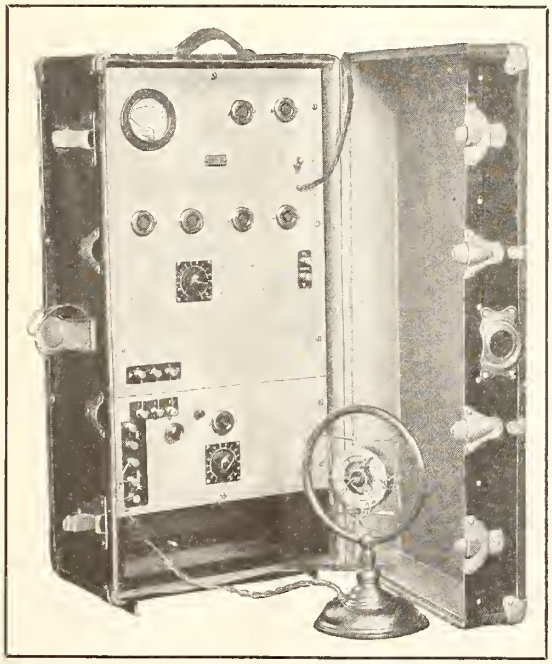
NEARER AND NEARER » »

. . . comes the day when ultra-speed motion picture negative will eliminate slower emulsions. The latest impetus is supplied by the new gray backing on Eastman *Super-sensitive.* This advance is of particular interest to the exhibitor and the producer. Definitely improving photographic quality, it means more artistic, more pleasing, more satisfying pictures. And these factors have definite box-office value. Eastman Kodak Company, Rochester, New York. (J. E. Brulatour, Inc., Distributors, New York, Chicago, Hollywood.)

EASTMAN *SUPER-SENSITIVE*

Panchromatic Negative, *Type 2*

One Glance Will Convince Any Engineer of the Superior Construction of a



MODEL PA 701
A portable all A.C. operated address system with a 4-stage Hi-gain circuit with UX 250 push-pull output—
Price $290.00.

GATES ADDRESS SYSTEM

Gates Engineers have been designing and building speech input equipment for ten years. The fact that approximately 150 Radio Broadcast Stations—15 universities and colleges as well as many theatres, recording laboratories, army cantonments and government institutions are using Gates Equipment is a real assurance of the approval of the best engineers for dependability and quality.

Send for Bulletin No. 25 today.

GATES RADIO & SUPPLY CO.

Manufacturing Engineers

Quincy, Illinois

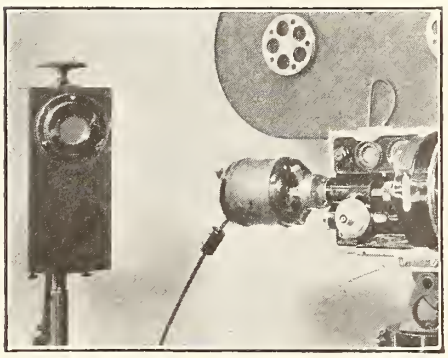
A NEW RECORDING SYSTEM

A new film recording system, elements of which are herewith illustrated, is the invention of Mr. Don Canady, of Cleveland, Ohio.

In the inventing and designing of this recorder Mr. Canady has made useful application of knowledge gained by 22 years' experience in the projection and radio engineering field and, more recently, with the technical side of sound pictures. He is a member of the Institute of Radio Engineers and the Society of Motion Picture Engineers.

Through the middle west Canady is known because of his developments in motion picture equipment. Among these are the Canady automatic volume control for sound picture work, the Wonderphone sound reproducers for film and disc and highly improved silent camera movement for sound work.

As early as 1916 Canady perfected and built the first 50 Peerless arc lamp controls which later became the McCauley arc lamp control and is now a part of the General Theatre Corporation's list. He was among the first to receive a commer-



cial wireless operator's license, first class, from the government under the act of 1912.

As cameraman the inventor was chief for Argus Enterprises and Bradley Feature productions. He served as cameraman for the Committee on Public Information for the Government during the war.

His practical experiences in projection and sound work covers a long period. He is now a member of Local 666 of Chicago, having formerly been a member of the New York local.

Canady is maintaining offices at 714 Leader Building, Cleveland, under the firm name of Canady Recording Equipment Company.

▲

BETTER LIGHTING EFFECTS

Two more projection rooms have gone in for high class stage lighting effects. They are those of the Wilshire-Western Theatre, of Los Angeles, and the Stanley, of Pittsburgh, each of which are now equipped with Hall and Connolly EF-4 spotlights, which were shipped them on a recent order.

That Hall and Connolly business is not coming from theatres alone is indicated by recent sale of four HC-4 projection lamps to International Projector Corporation, for export, while another order, this time for two FR-10's, was from the Arco Electric Company, of New York, for shipment to Rohlig & Co., of Bremerhaven, Germany.

Three more FR-10 lamps are now doing service in the industrial field. One at the plant of the Donaldson Litho Co. at Newport, Ky., and two at the Dayton plant of the National Cash Register Company.

▲

FALL MEETING OF S. M. P. E.

The fall meeting of the Society of Motion Picture Engineers will be held at the New Ocean House, Swampscott, Mass., October 5 to 8, according to an announcement made by the Board of Governors following its meeting held in Schenectady in August.

▲

NEW BOOK ON CINEMATOGRAPHY

James R. Cameron will have ready for distribution in November a new book entitled "Sound Cinematography." The book will cover the making and showing of pictures with sound, written for the amateur and for those who are likely to be called upon to operate the equipment in schools, churches and auditoriums. Mr. Cameron's address is Woodmont, Conn.

▲

SILENT GEARS

The Continental Diamond Fibre Company, Newark, Del., has issued a booklet illustrating and describing a line of silent and long-wearing gears which will have a wide application in the moving picture industry.

▲

MOTOR SPEED REGULATORS

Ward Leonard speed regulators are designed for use with constant torque and variable torque a-c. and d-c. fractional horsepower motors. They are built to conform with N.E.M.A. Classifications Numbers 93 and 95 and are listed as standard apparatus by Underwriters' Laboratories. The Underwriters' listing is given under "Industrial Control Equipment—Motor Controllers—Manual" as number 1101. This number appears as the first four digits of the identifying number on the name plate.

These regulators can be furnished for use with series-wound a-c. motors. When so used, the rheostat usually has no "off" point or the full speed position is located next to the "off" point to assure full torque at starting.

These regulators are furnished with a moulded knob designed to indicate the position of the contact arm.

As the current capacity and resistance required for proper control of a-c. fans or motors varies widely, no rheostats are listed for this service, but prices and information will be furnished on request.

These regulators are manufactured by the Ward Leonard Electric Company, Mount Vernon, N. Y.

▲

"AUDIO AUTO" ATTRACTS ATTENTION—AN ADVERTISING ASSET

Sound systems are being used successfully for advertising purposes in many different kinds of installations. The "Audio Auto," however, seems to surpass all the other forms in general effectiveness. No matter how often the sound equipped car appears on the streets, it invariably attracts unusual attention.

The "Audio Auto" operated by the General Sound Equipment & Advertising Co., of Beaver Falls, Pa., is equipped with a complete sound amplifying system, furnishing reproduction as nearly perfect as it is possible to obtain in an installation of this type. The apparatus is built into a Pierce Arrow limousine.

Two Wright-DeCoster dynamic reproducers of the 207 model, are located on the roof of the car. These are mounted in No. 9 horns, one facing the front and one the rear. The design of these horns is such that they will cover a large area

at not too great a distance. Incidentally, these horns are completely weatherproof.

Two additional loudspeakers are located within the car. These are model 217 Jr., Wright-DeCoster dynamic reproducers. They are used with No. 4 baffles, mounted at the right and left rear windows. As a result of the excellent arrangement of the four dynamic speakers, the amplified sound can be heard equally well on all sides of the car.

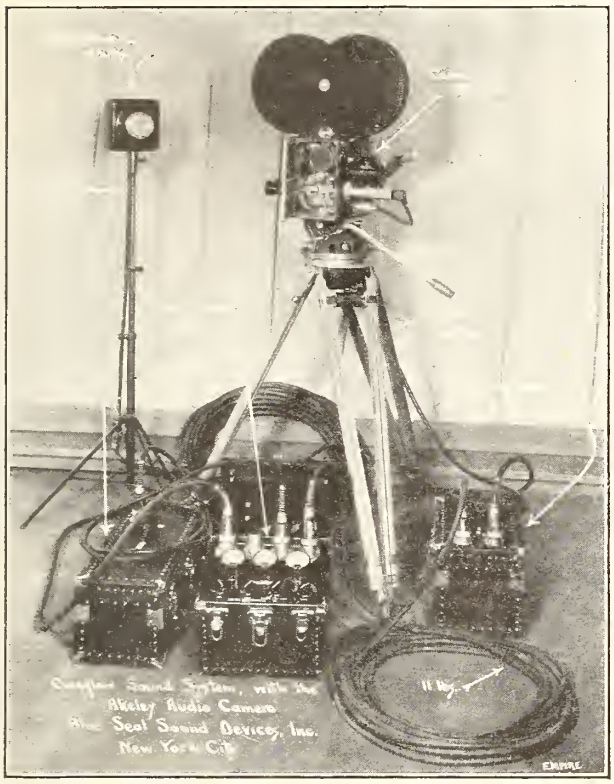
The amplifier equipment is mounted on a standard rack and panel, located inside the car towards the rear. This includes a microphone amplifier, a two-stage amplifier for supplying a suitable input signal, and a more powerful single stage amplifier. The microphone amplifier is a two stage unit, employing a 127 Arcturus tube in each stage, with a 180-type rectifier. This amplifier is provided to furnish button current to a two-button Universal carbon microphone and to amplify the output of the microphone sufficiently to supply input signal voltage to the two-stage power amplifier. The latter is operated either from the output of the phonograph pickup or from the microphone amplifier. It uses a 127 tube in the first stage and two 112A tubes in push-pull in the last stage. The final amplifier, capable of providing a maximum undistorted output of 15 watts, employs a single stage with two Arcturus 150 power output tubes in push-pull arrangement.

For supplying music, an electric phonograph turntable is used, equipped with a pickup. A model "BB" Universal microphone is encased within a model "L" desk mount with covers. The microphone is located on an extension rack, situated near the front of the car.

The a-c. power is supplied by a converter, which in turn is driven by a 32 volt storage battery. All of the controls, switches, etc., are mounted on the instrument panel of the automobile.

Although the "Audio Auto" has been in operation only a short time, it has already paid for itself in new business directly traceable to it. This car was equipped by the Sanderson Sales Company, of Pittsburgh, Pa.

Cineglow Systems—A Life Time Investment that always pays dividends!



NO matter where you are, or what your position is, your future income will be assured in Sound Recording. Every town needs industrious cameramen to handle merchant-theatre tieups. Local news events, industrial and educational shorts are in great demand. Let us tell you more about Cineglow Sound Systems and how the 3rd element makes high grade glow lamp sound recording possible.

Here's what we can offer!
Try to duplicate it elsewhere.

The Famous Cineglow Three Element Recording Lamp. The Cineglow Optical Slit. Mechanically Filtered Sound Sprocket. *A LICENSED AMPLIFIER.* An equipment that records the highest quality—and does it consistently.

Any Special Equipment Made To Order

Single System — Newsreel Type
Double System — Studio Type

Write, Wire or Cable for Particulars

Cineglow Sound Systems

MANUFACTURED BY

BLUE SEAL SOUND DEVICES, Inc.

130 West 46th St., New York City

Cable Address: SOUNDFILM, New York
European Representative: N. V. World Industrial Co., Hague, Holland

INDICATES

SOUND LEVEL

● With Weston Model 571 OUTPUT METER, correct sound volume in the auditorium may be determined from the projection booth.

● Model 571 measures the voltage output of sound apparatus—at speakers or any other convenient point. Notation may be made of the voltage outputs that produce the correct sound level for different capacity audiences. After this, the sound level may be regulated reliably and definitely from the booth by checking voltage output.

● Variations of voltage output—a possible breakdown—are immediately indicated with Model 571. This warning enables a change-over to the reserve circuit without annoyance to the audience.

● Besides, Model 571 OUTPUT METER is used for checking the relative volume of speakers, for determining the relative gain of tubes, and for determining fader settings.

● Developed to solve a practical problem that confronts every projectionist, Weston's 571 OUTPUT METER helps satisfy critical audiences. Its moderate price brings it within reach of every one interested in quality sound reproduction.

Write for circular RR

WESTON

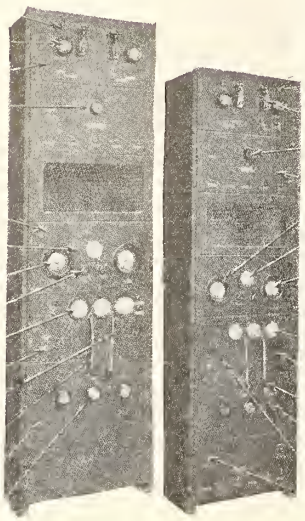
ELECTRICAL INSTRUMENT CORP.

608 FRELINGHUYSEN AVENUE . . . NEWARK, N. J.

TREMENDOUS SAVINGS
and Motor Generator Sets

The equipment offered on these two pages is brand new and was manufactured by General Electric and Westinghouse for R.C.A. Photophone, Inc. The quantities in some cases are limited, we therefore suggest, that, should you be interested, that you communicate with us at once.

This fortunate purchase permits us to offer this equipment at from twenty to forty per cent of its real value. All this equipment is brand new, and limited in quantity.



AMPLIFIERS
Type "A" Main Amplifier Complete

(a) 1 Input control panel.
(b) 1 Voltage amplifier panel.
(c) 2 Power control panels.
(e) 1 Rheostat panel.
(f) 1 Loudspeaker switch panel.

Uses following tubes—10-UX845 2-UX210-1-UX841

This amplifier has an input control panel for theatre work, giving control for A & B projectors or turntables

The voltage amplifier is designed for photo cell or magnetic pick up.

The power amplifier has 10-UX845 tubes which gives an output of 250 watts.

The power control panel provides necessary control for motor generaator set. All plate and filament voltages are supplied by a four unit motor generator set described on next page.

Loud speaker panel provides means of switching loud speakers on or off separately or in groups.

This powerful amplifier is suitable for large buildings, hospitals, schools, etc., where centralized radio is needed. Also public address systems and outdoor amplification.

OUR PRICE $300.00

Type "A" Auxiliary Amplifier Complete

This amplifier is the same as above without loud speaker panel. Used as stand-by unit. Sold separately or with above unit.

OUR PRICE $300.00

Type "B(M.G.)" Amplifier Complete

(a) 1 Input and voltage amplifier panel.
(b) 2 Power amplifier panels.
(c) 1 Power control panel.

Uses following tubes—8-UX845-2-UX210-1-UX841. The voltage amplifier panel consists of voltage amplifier, indicator pilot lamps, excitor lamp rheostat, test meter, jacks and phonograph pick-up. There are two identical power amplifier units, each using 4 UX845 tubes giving total output of 200 watts.

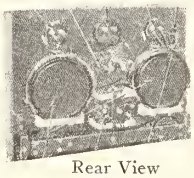
The control panel regulates field current of motor generator set. This unit is operated by the four unit motor generator described on opposite page. The loud speaker switch panel has six snap switches, three for output of each amplifier.

This amplifier is adaptable for public address systems, schools, hospitals, hotels and wherever centralized radio is needed.

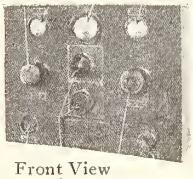
OUR PRICE $250.00

Input Control Panel

(1) 1 Input control panel (with volume control) type PA-16A.



Rear View



Front View

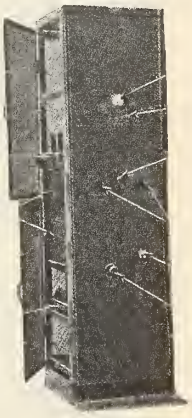
Contains necessary switches and controls for operating excitor lamps or changing output from one projector or turntable to another. Includes volume control.

OUR PRICE $50.00

Same unit as above but without volume control.

OUR PRICE $50.00

Preview Booth Amplifier



(a) 1 Voltage amplifier PA-12A.
(b) 1 Power amplifier PK-1A.
(c) 1 Control panel.
(d) 1 Battery box.

Uses following tubes—6-UX112A 2-UX250-2-UX281.

Designed for receiving room use. Also useful for laboratory, experimental work or other uses where moderate power amplification is suitable. Such as, small public address systems and small buildings, etc. Uses photo cell or magnetic pick up.

Power amplifier uses 2—250 tubes and 2—281 tubes. This is a 3 panel rack with voltage amplifier unit—with 3 stages of push pull amplification, using 112A tubes. Voltage amplifier is battery operated, and has power amplifier of 1 stage push pull amplification, using 2—250 tubes. The power amplifier if A.C. operated using 2—281 tubes, for plate supply and rectox unit for loud speaker field supply. The output load for loud speaker is 12 Ohms.

OUR PRICE $70.00

Portable Amplifier

(1) 1 Amplifier cabinet equipment, type PA-23A. (2) 3 Plugs.
Uses following tubes—2-UX250-3-UX281-2-UX227-2-224.
This amplifier comes packed in a trunk, and is complete with tubes.

OUR PRICE $150.00

24A Amplifier

Uses following tubes—1UX250-1-UX226-2-UX281.
This is a General Electric Amplifier.

OUR PRICE $30.00

Loudspeakers

12-in. Dynamic Loudspeaker Unit

OUR PRICE $7.50

Safety Switches

Trumbull Electric Cat. No. 70321, 30 amp., 3 pole, double throw, 250 volt, fusible both ends.

OUR PRICE $5.00

Housing for M.G. Set Type G.

OUR PRICE $7.00

Battery Charging Switch

Trumbull Electric Cat. No. 70422, 60 amp., 250 volts, 4 pole, double throw, fusible both ends.

OUR PRICE $5.00

PBE General Electric Volume Control Panel

OUR PRICE $2.00

TERMS: 20% with order, balance C.O.D. Shipped F.O.B. Brooklyn, N. Y.

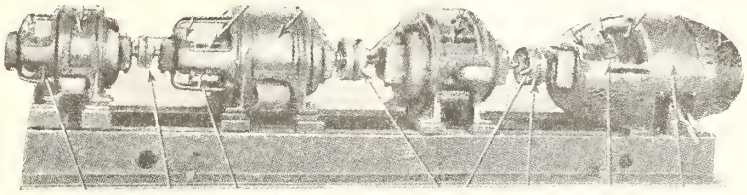
UTILITY SPECIALTIES
1450-A BROADWAY, Continental

IN SOUND EQUIPMENT

Brand New—Late Models

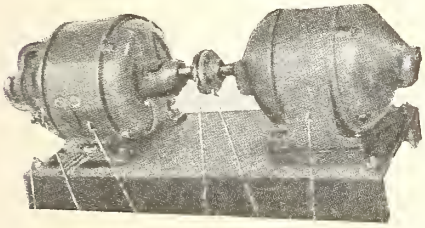
Engineers considering replacement of present amplifying equipment or installation of new equipment for public address systems, centralized radio, etc., will find the necessary components available in this special sale. Amplifiers, loud speakers, transformers, M.G.-sets, rectifiers, etc., offered, will find ready application for laboratory, testing or experimental purposes and can be purchased at considerable savings. Only the finest quality component parts are used in this equipment.

MOTOR-GENERATORS



1½ KW. A.C. to D.C. Motor-Generator Set

(1) 1½ KW. A.C. to D.C. M.G. set with 110-220 volt, single-phase 60 cycle A.C. motor and 125 volt D.C. generator.



Suitable for any purpose where A.C. supply is not suitable for power use, i.e.; variable supply motor control, replacement or stand-by use for projector drive motors.

OUR PRICE **$80.00**

1½ KVA. D.C. to A.C. Motor-Generator Set

(1) 1½ KVA. D.C. to A.C. M.G. set (G.E. model 12-A-79) with 3 h.p. 110 volt D.C. motor and 1½ KVA., 110 volt, single phase, 60 cycle A.C. generator.

OUR PRICE **$150.00**

Four Unit Motor-Generator Set

1—115 Volt D.C. Motor
1—250 Volt D.C. Generator
1—15 Volt D.C. Generator
1—500-1000 Volt D.C. Generator

DESCRIPTION

1—D.C. GENERATOR
Shunt-wound — Speed 1800
Amps. 1.6 — KW. 4
Volts 250

1—D.C. GENERATOR
Amp. 67 — Sept. Exc. at 250 volts
Speed 1800
Shunt-wound — KW. Cont. 50
15 volts

1—D.C. MOTOR
Shunt-wound — Volts 250
Open continuous Horsepower 5
Amp. 19 — Speed 1750
Closed Horsepower Continuous 140

1—D.C. GENERATOR
Amp. 1 — Volts 1000
Speed 1800 — 1 KW. Cont.
Shunt-wound

1—220 V. 3 ph. 60 cy. motor, A.C.
1—250 Volt D.C. Generator
1—15 Volt D.C. Generator
1—500-1000 Volt D.C. Generator

DESCRIPTION

1—55D.C. GENERATOR
Shunt-wound 4A — 1 Amp. at 500 v.
Amp. 1 — 5 Amp. at 1000 v.
Volts 1000 — 1 KW.
Speed 1800

1—INDUCTION MOTOR
Volts 220 — 3 ph.—60 cy.
Amp. 10.1 — Speed 1750

1—GENERATOR
Shunt-wound — Amp. 67
Volts 15 — Speed 1800
1 KW.

1—D.C. GENERATOR
Shunt-wound — Amp. 1.6
Volts 250 — Speed 1800
.4 KW.

These units were designed for power supply to main amplifier equipment described on opposite page. It is also suitable for broadcasting stations, centralized radio and public address systems and other equipment where voltage supplied is needed. The 1000 volt generator has 2—500 volt connections in series giving total of 1000 volts.

OUR PRICE **$250.00**

Rectifier for Battery Charging

(1) 12 Ampere Tungar or Rectigon Rectifier.

TUNGAR RECTIFIER
Consists of transformer, two Tungar Bulbs, ammeter and line switch, mounted in sheet iron case.

RECTIGON RECTIFIER
Same as above with charging rate control knob.

OUR PRICE **$40.00**

BATTERY CHARGERS

A.C. Motor Generator Set for Battery Charging

½ KW. Battery Charging M. G. set with 110 volt, single phase, 60 cycles, A.C. Motor.

DESCRIPTION

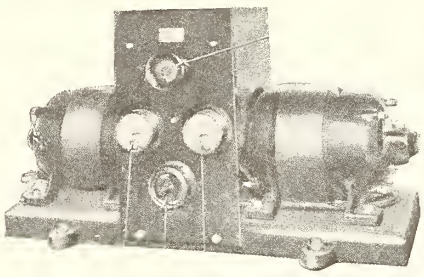
A.C. Motor	D. C. Generator
Speed 1725	18 volt
Cycles 60	Amp. 27-8 KW. .5
Phase 1	Speed 1725
Temperature-rise 50%	Temperature-rise 50%
Time rating continuous	Time rating continuous

D.C. Motor Generator Set for Battery Charging

½ KW. Battery Charging M. G. set with 110 volt, D.C. motor.

DESCRIPTION

D.C. Motor	Volt 18
Speed 1725	Amp. 27.8 KW. .5
Shunt-wound	Speed 1725
Temperature-rise 50%	Shunt-wound
Time rating continuous	Temperature-rise 50%
D. C. Generator	Time rating continuous



These generators are suitable for charging batteries in theatres, broadcasting stations, laboratory, lamp and tube life testing. Also for replacement of present worn out equipment.

OUR PRICE **$50.00**

TRANSFORMERS

SINGLE-PHASE TRANSFORMER 2KVA.
(1) Transformer, 115/230 to 230/115 volts, 50-60 cycles, 2 KVA., single-phase.

OUR PRICE **$9.00**

SINGLE-PHASE TRANSFORMER 1 KVA.

(1) Transformer, 115/230 to 230/115 volts, 50-60 cycles, 1 KVA., single-phase.

OUR PRICE **$5.00**

1½ KVA. AMERTRAN

1½ KVA. 220 volts, 60 cycles. 4 wire, American Transformer Co. Secondary tapped at ½ and .866 bolt.

OUR PRICE **$12.00**

Starter for 1½ KVA. DC. to A.C. M.G. Set

1 Starting switch, 3 Horsepower, 115 volts, D.C.

OUR PRICE **$5.00**

Starting Switch for D.C. Motor-Generator Set

(1) Starting switch, 1 Horsepower, 115 volts, D.C.

PRICE OUR **$7.00**

Battery Charging Switch

(1) 4 pole, double-throw charging switch.
Trumbull electric Cat. No. 70421.

OUR PRICE **$6.00**

Selective Switching Panel for A.C. to D.C. Motor-Generator Set

(1) Selective switching panel (W. E. & M. style 95-C-636 for two A.C. to D.C. M-G sets.

OUR PRICE **$30.00**

Fuse Panels for "A" and "B (M.G.)"

1 Low voltage fuse panel.
1 High voltage fuse panel.

OUR PRICE **$30.00**

Starter for 1½ KW. AC. to D.C. Motor Generator Set

(1) Starting switch 3 h.p., single-phase, 60 cycle, 110/220 volts.

PRICE OUR **$5.00**

Control Panel for D.C. to A.C. Motor Generator Set

(1) Control panel (GE-CR2909-Y1)

OUR PRICE **$10.00**

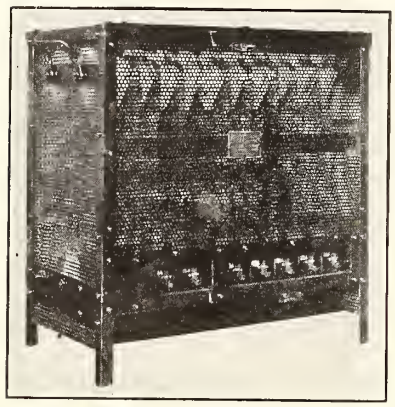
CORPORATION

Building, NEW YORK CITY, N. Y.

GUARANTEE: All equipment is guaranteed to be brand new and in original factory crates.

ask the fellow who *owns one!*
• • • • • • • he'll tell you

HOFFMANN-SOONS RHEOSTATS *are perfect!!*



Every PERFECTION RHEOSTAT has satisfied its owner. Breakdowns, service-calls and trouble are unknown to *Perfection* users.

THE ONLY UNION MADE RHEOSTAT

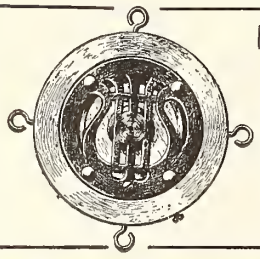
Recognized as the Highest Standard everywhere.

Now equipped with solderless, adjustable lugs to take wire sizes from No. 4 to 4/0 without any additional cost.

We build rheostats for special requirements. Communicate with us Direct. There is no obligation.

Sold by all Branches of National Theatre Supply Co., Sam Kaplan, New York, Continental Theatre Accessories, and by your dealer.

HOFFMANN-SOONS
Electrical and Engineering Corporation
387 FIRST AVENUE, NEW YORK
Contracting Electrical Engineers—Moving Picture Theatre Electrical Specialists



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"DELIVER THE GOODS"
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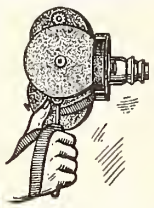

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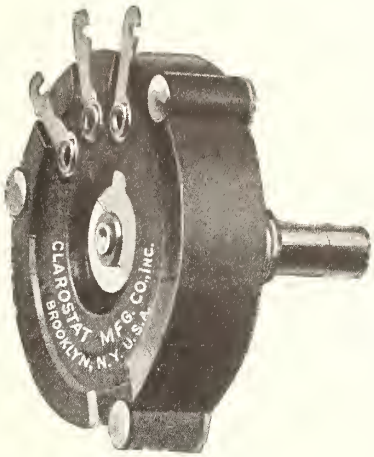

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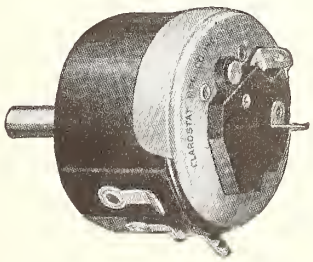

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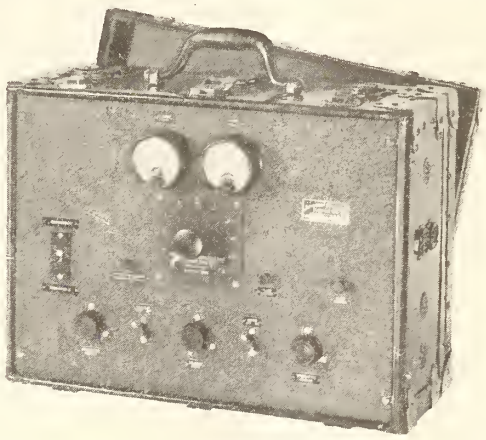

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the NEW Amplion

OCTOPHASE

heavy-duty dynamic unit

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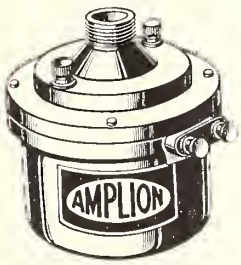

LEGEND:

In the Octophase, the space between a scientifically domed piston diaphragm of great rigidity but extreme lightness, is divided into eight divisions with three sections in each division, twenty-four sections in all. Channel ways are provided for conveying the sound impulses from these twenty-four sections to the throat of the horn. Space and time relations are so designed that the impulses from each space reach the throat of the horn at the same moment in perfect synchronism. By means of this construction, there is realized great efficiency, greater frequency range and the ability to reproduce tremendous volume without blasting. Music is reproduced in its full range and speech is reproduced with a finesse that retains every shade of human emotion. From these eight divisions, OCTOPHASE derives its name.

The efficiency of this unit is from six to eight hundred per cent greater than that of cone speakers, and is the equivalent of an extra stage of amplification. High sound levels are obtained with less amplification permitting the operation of amplifiers below distortion levels, improving the quality and increasing tube life.

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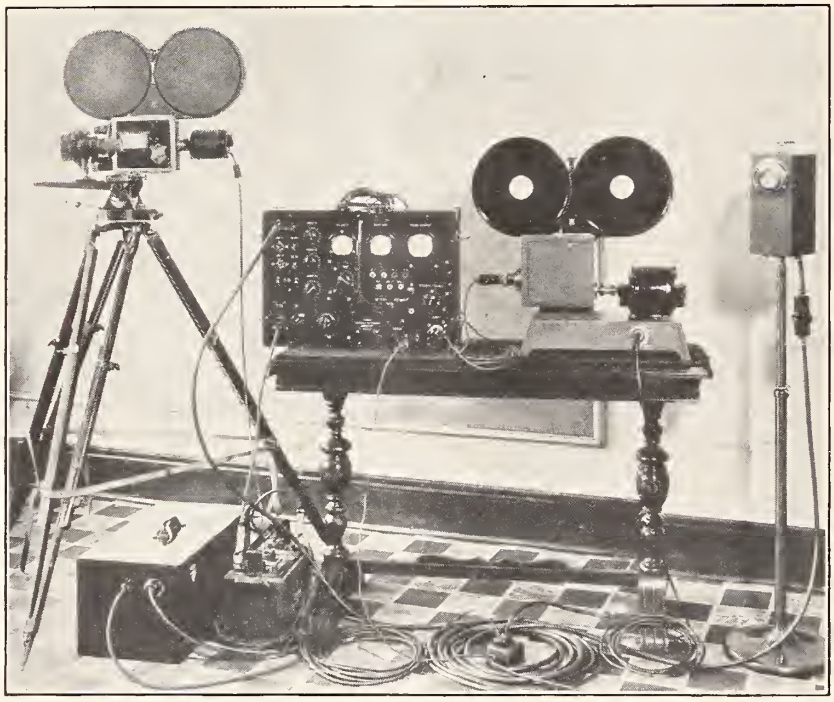

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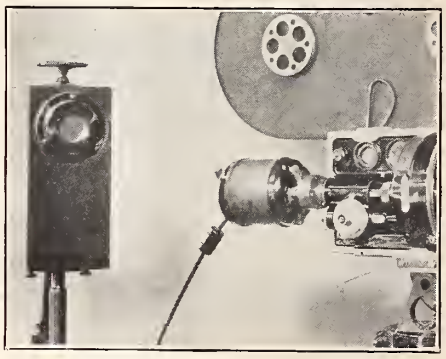

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CANADY RECORDING EQUIPMENT COMPANY

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OCTOBER, 1931

PROJECTION ENGINEERING

SOUND - VISUAL

(Photo., courtesy Samson Electric Co.)

Loudspeaker Equipment, One End of Field, of a Football Stadium in Texas.

THE JOURNAL OF THE SOUND AND LIGHT PROJECTION INDUSTRIES

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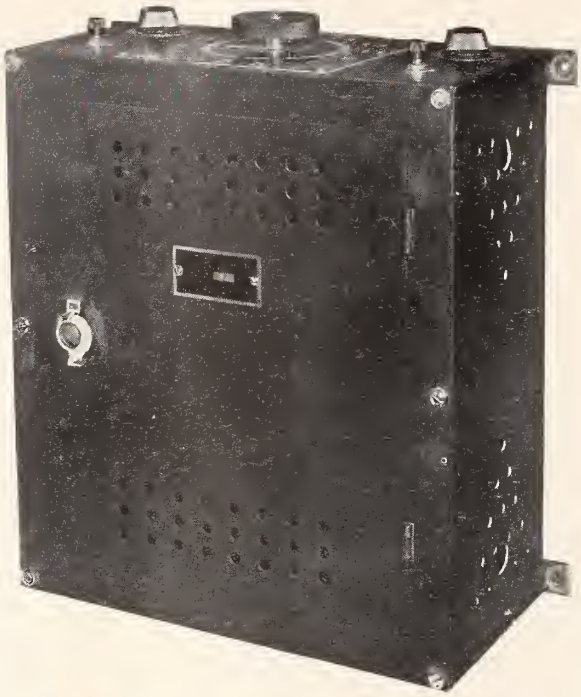
A COMPLETE AMPLIFICATION AND POWER SUPPLY SYSTEM

FOR TWO SOUND HEADS

WITH FADER AND ALL CONTROLS BUILT IN



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A TRULY PROFESSIONAL sound-on-film projector that is in the fullest sense of the word *portable*. The entire equipment disassembles into compact, easily handled units, no one of which weighs over 65 lbs. Can be easily transported in the back of a standard sedan automobile and handled by one man.

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Editorial

OCTOBER, 1931

HOLLYWOOD COSTS

THE September meeting in New York of the Motion Picture Theatre Owners of America and Allied States Exhibitors' Association, participated in by representatives from eastern Pennsylvania, southern New Jersey and Delaware, was heralded as a campaign to deflate Hollywood and "save the motion picture industry."

It is noted that when the harrassed exhibitor, struggling to show a profit, stages a protest against his costs, he usually makes much of the reported fabulous salaries paid to performers and executives in Hollywood.

When costs are being analyzed it would be constructive to have at hand figures showing all of the outgo in Hollywood. For instance, it may be disclosed that taken as a whole the studios use in a year forty million linear feet of lumber; $200,000 worth of paint; 10,000 paint brushes; seven million square feet of wall board; 100,000 yards of burlap; 5,000 tons of crushed rock and cement, 10,000 tons of plaster, etc. This is aside from the large sums paid out for electrical equipment.

It is stated also that approximately twenty billion watts of electrical energy are consumed annually, and that 11,000 working hours of building trade labor are used daily. The lumber purchased in a year would be sufficient to build 2,600 five-room homes.

If some of the money spent by certain moving picture companies to ballyhoo degrading "sex" plays and gangster pictures were expended in showing the American people that here is a great materials consuming industry, a healthier regard for the business might be developed, which would offset some of the present widespread criticism.

▲

MATERIAL FOR PICTURES

IT IS reported that Earl Lockwood has departed for what is left of the Indian country in the Canadian Northwestern provinces for the purpose of making a dozen two-reel films. There is a wealth of material in the Canadian west awaiting the inquiring camera.

While there are still alive old timers in the Saskatchewan country who could assist in reconstructing the stirring battles with the Indians, at Duck Lake and Batoch, in 1885, the camera and the microphone should be given opportunity to make the records.

The outstanding public approval of "The Iron Horse," "The Covered Wagon" and "Cimarron," should point the way to other like fields of promise. Recently we saw the manuscript of an account of Champlain's first attempt to follow the Indians across America "to the shores of Cathay." There is more of real history, more of gripping adventure, and of wholesome entertainment in the gun play of the Seventeenth Century in New France than in all of the cheap, cowardly modern gangster pictures which during the past year have caused a storm of protest from thinkers who are concerned with the education of American youth.

In the alarms and excursions of high adventure what trek surpassed the journey of Woolsey across Canada to Fort Garry years before the railroad was projected? Here is historical material at hand for the filming—material of a nature worthy of the new art of pictures with sound.

Good luck! to Mr. Earl Lockwood.

▲

A GOOD SUMMER

IT IS reported that for the week of August 9, gross business in all R. K. O. theatres broke the high record for the circuit. The gain was about $90,000.00 over the previous week. In Detroit, Mich., seven theatres were running all night shows. In one week in August Warners' First National products sales are said also to have set a new high record.

Fall is coming—and Christmas!

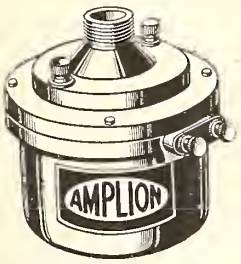
▲

Donald McNicol

Editor

TO HEAR
SPEECH AT ITS BEST
HEAR
THE AMPLION OCTOPHASE
Heavy-Duty-Dynamic-Speakers

The Unit



OCTOPHASE

LEGEND

In the Octophase, the space between a scientifically domed piston diaphragm of great rigidity but extreme lightness is divided into eight divisions with three sections in each division, twenty-four sections in all. Channel ways are provided for conveying the sound impulses from these twenty-four sections to the throat of the horn. Space and time relations are so designed that the impulses from each space reach the throat of the horn at the same moment in perfect synchronism. By means of this construction, there is realized great efficiency, greater frequency range and the ability to reproduce tremendous volume without blasting. Music is reproduced in its full range and speech is reproduced with a finesse that retains every shade of human emotion. From these eight divisions, OCTOPHASE derives its name.

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THE HORNS

SPECIFICATIONS

Amplion horns are made of wood. The walls of Amplion horns have a density comparable with that of mahogany. Their great density offers maximum resistance to vibration and eliminates objectionable wall noises.

The interior surfaces of Amplion horns are polished to a fine finish. Measurements show these smooth piano polished interiors to be 50% more efficient in projecting harmonics above 4000 cycles than the rougher absorbent surfaces of softer horns. Amplion horn are non-porous. Though magnificently painted with several coats, they do not rely on a painted surface to make them weather-proof. Amplion horns are sound from surface to centre. Summer suns, pouring rain and biting frost, cannot drive out of them the inherent quality which Amplion builds in them. Amplion uses only square-mouthed horns. The square bell provides 27% more area than a circular bell of the same diameter. The straight side of the square bell is ideal for use in multiple horns, since the sides match without leaving the gaps or dead areas inevitable in putting the bells of circular horns together. AMPLION HORNS will improve your acoustics or your money refunded.

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Twin Trumpet 6½-ft.	112.00
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Triple Trumpet 6½-ft.	168.00
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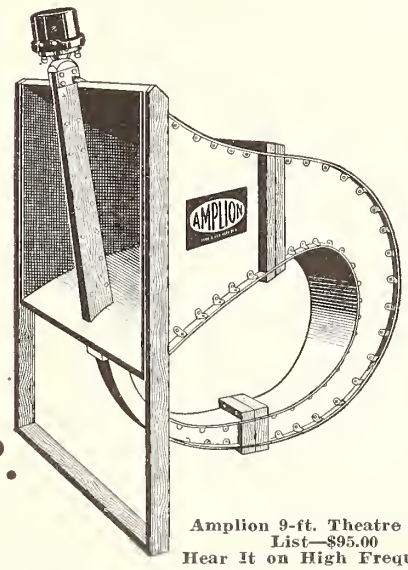

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- Power Amplifier.
- Dynamic Speaker.
- Complete set of tubes.
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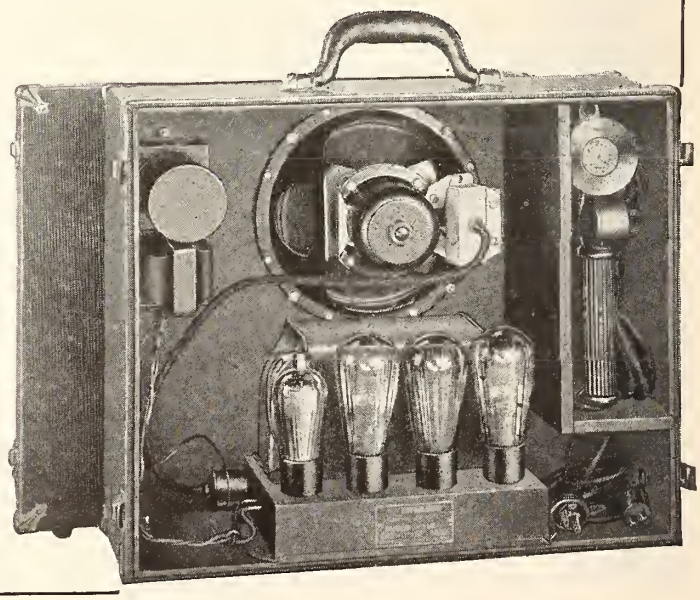


Projection Engineering

OCTOBER, 1931

Sound motion pictures and education

By Gordon S. Mitchell*

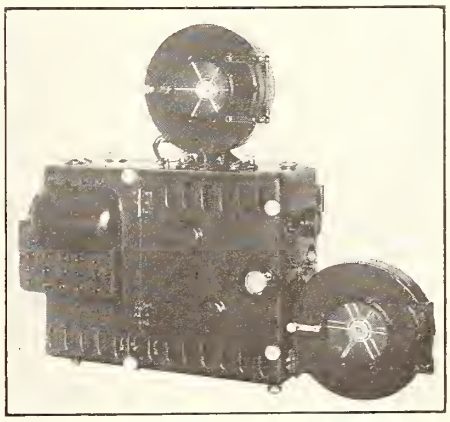
There is in the United States a slowly gathering storm of protest against the scandalous rise in the cost of education. The talking picture and a new technique of school instruction are the elements of the best promise we have of relief for taxpayers.

DURING the trying period which immediately followed the sudden application of sound to motion pictures, the entire energies of all producers were bent towards a technical perfection of the medium and little attention was paid to the broadening of the fields to which sound pictures might be applied. With the technical advances which have been made since that time which allow a slowing down of the efforts toward perfecting the sound picture, there has been of late an increasing interest in the application of the medium to education.

Tests held during the month of July in Washington, D. C., which were designed to determine the absolute value of the talking moving picture in educational work were surprisingly successful. Held under the direction of John Cooper, Federal Commissioner of Education, at the suggestion of President Hoover, the tests gave results which unalterably showed the value of the moving picture in teaching the child, and in addition, when compared with the results of similar tests given some years ago with silent films, showed the value of sound with the motion picture. The report of Commissioner Cooper, showed that boys and girls (of which one each with an instructor was chosen from each of forty-seven states and the District of Columbia) answered correctly on an average nineteen more questions out of fifty on each test after seeing the sound film on the subject than they were able to before. This is an average gain of thirty-eight per cent. Results of the tests held several years ago with silent films showed an average gain of nineteen per cent. A comparison of the two tests seems to show, according to Commissioner Cooper, that the sound film is just twice as effective in teaching power as the former silent picture.

In a consideration of a test of this kind, the subject matter chosen for the test is of course important. In the tests under discussion, the five subjects chosen were "volcanoes," "glaciers," "rivers," "toads," and "monarch butterflies." All boys and girls graduating from the eighth grade are given more or less instruction on the subject of "glaciers," hence it would be expected that a picture on this subject would result in the least gain in knowledge on the part of the children. Such was the case. However, after seeing a thirty-minute film on the subject an average gain in knowledge of forty-two per cent was recorded. The subject of "monarch butterflies" is given little or no exposition in the ordinary school curriculum, consequently this picture would be expected to result in the greatest gain. After looking at it for twelve minutes, the children knew more than six times as much about the subject as they did before—a gain in knowledge of 607 per cent being recorded on this subject. The average gain in knowledge for all five subjects was 115 per cent—in other words, after looking at educational films for a total of two hours and four minutes, these children knew more than twice as much about the subjects being shown than they did beforehand. When given consideration, the results of these tests are truly startling.

The tests were given by a committee of experts appointed by the Commissioner of Education which gave the boys and girls a preliminary examination at George Washington University to ascertain their fund of knowledge on the group of subjects. On the three days following, the educational sound pictures on the same subjects were run, after which the children were given another set of examinations to determine how much they had gained from the pictures which they had seen and heard. In order to determine the different degrees of intelligence of the children, they were given the Terman group test of mental ability. Classifications from this test showed that the greatest gain was made by the girls of average intelligence, while the boys of highest intelligence ran a close second.



Acme 35mm. portable sound-on-film projector. Manufactured by International Projector Corp.

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N. E. A. Convention

There was held recently in Los Angeles a convention of the National Education Association. Probably the most popular spot in the whole convention was a small convention room seating perhaps two hundred people high in the auditorium. This projection room was open every day, all day, for a week and there was never a vacant seat. Educational pictures, produced in the East, were formally exhibited to all interested members of the Association. One company has already produced twenty two, one and two-reel pictures which are regularly being shown in over 2,000 churches, schools, clubs and private projection rooms throughout the United States. Before the education convention had closed officials of the University of California had contracted for the entire series of pictures so far produced for use in the summer session and in the extension division of the university. This means that during the next few months over thirty thousand students of the university will be given the opportunity to see and hear these pictures.

The growing popularity of the travel type of motion picture is only one indication of the thirst of the motion picture public for knowledge. Coupled with dissatisfaction noted in many quarters with the quality of the present-day motion picture, this interest in informative and educational motion pictures is resulting in an increasing number of such pictures being put into production. The few biological pictures which have been filmed showing the processes of natural life have proven to be as fascinating as any one of the thousand and one tales of the Arabian Nights. Such pictures, whether made for schoolroom use entirely or with the idea of exploitation from an entertainment standpoint, will undoubtedly overflow into the theatre providing they are properly produced.

The Equipment

In any consideration of educational sound pictures, a discussion of the projection equipment available is of importance. Especially is this true inasmuch as at the present time it is generally agreed that a lack of suitable, reasonably priced equipment is definitely holding back the rapid spread of the educational picture. At the present time there are available sound films for schoolroom use on 35 mm. film with sound recorded on either film or disc, in addition to a more limited number of subjects on 16 mm. film with sound on disc only. There have been no subjects put upon 16 mm. film with sound recorded on the film. It may be, of course, that the laboratories are at work on the development.

Economics

While the matter of funds available for equipment is usually the limiting factor in the selection of projection equipment, it should be borne in mind that if the reproduction is not as good or better than in the ordinary theatre, sound pictures will not be successfully used in education. All students attend a motion picture theatre more or less regularly and their judgment is set unconsciously by the quality of reproduction made available to them there. If the reproduction be not as good in the school as in the theatre their attention will be drawn away from the subject matter and placed upon the material reproduction of the sound.

There are several alternate courses open to the authority who is charged with the provision of sound motion picture projection equipment for school use. For the school with more or less unlimited funds for the equipment, of course the best method is to lease the equipment from one of the several companies organized for the purpose, paying a periodic service charge and obtaining the same service received by the larger theatres. For those institutions which have lesser funds available, equipment such as is designed for the smaller theatre may be purchased outright, although in general quality will not be as good with these systems and the matter of service in case of trouble may prove troublesome. The third method, which has several points to recommend it, is to purchase the various component parts of the system and assemble them into an operating whole.

Opportunity For Ingenuity

Provided that there are one or more persons connected with the institution who are interested in such things, an eminently satisfactory projection system can be purchased in parts and assembled on the ground. The picture projector will of necessity be purchased as a unit. The necessary sound heads, turntables, amplifiers, control equipment, and projector horns can be purchased from any one of a number of reputable manufacturers, many of whom will make the services of an expert sound engineer available for consultation in the assembling of the system. There has recently been placed in service at the California Institute of Technology in Pasadena such a system which in the writer's opinion compares favorably with any sound projection equipment as heard in the theatre. Incidentally, it might be mentioned that for several years past motion pictures have been used in conjunction with the engineering courses given at the Institute, it being the usual practice to devote a certain number of assemblies every year to motion pictures of an educational nature, these assemblies being attended by the entire student body. Many of the films were furnished by industrial concerns and showed the processes through which their products went in manufacture. They have proven to be of great value in giving a clear exposition of certain engineering procedure which would be difficult if not impossible to obtain by explanation.

Projection equipment as installed for educational institution use should be assembled in such a manner that all insurance and underwriters' regulations will be complied with. It should be remembered that each projection machine should be provided with a ventilation duct over the lamphouse if a carbon arc is used. Plans and specifications as well as regulations governing the construction of projection booths may be obtained from the Society of Motion Picture Engineers. Certain other requirements governing the size of conduit to be used, type, etc., vary according to local regulations. City authorities should be consulted to make sure that all local ordinances are complied with.

In smaller institutions one projection machine will fulfill adequately all requirements, and a space of 10 by 12 feet will provide sufficient room for projection machine and sound equipment. If two machines are used, about five feet should be left between the machines and at least four feet between the right-hand machine and the wall. Additional space for stereopticon, spots and whatever auxiliary apparatus is needed should be provided. If the booth is being designed at the time of installation for sound projection equipment (in many cases it is desired to remodel a booth which has served for the projection of silent pictures) the ideal arrangement is to provide a separate room approximately 6 by 9 feet for amplifiers and associated sound apparatus. It is best practice to keep as much equipment as possible out of the booth in order to provide ample room for operating.

Projectors

While there are several portable sound motion picture projection outfits on the market (one such being described in PROJECTION ENGINEERING for June, 1931), which might be applied to educational use, it will in general be best to plan for a permanent installation. It is easier to move classes than it is to move and set up equipment as delicate and as complicated as a sound projection system. In addition, the auditorium or room used for the assembly can be treated acoustically and optimum reproduction obtained at

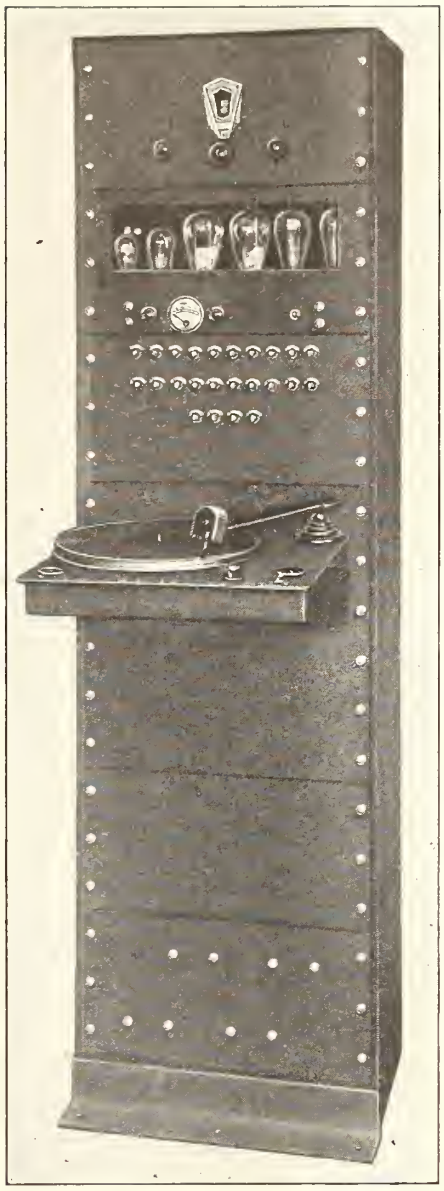
all times. Thus a permanent installation makes for better projection than would be possible were the system moved from classroom to classroom as needed. Finally, best operation of the equipment will be obtained if it is permanently housed in a suitable booth.

Sound Systems

The sound system as used in a schoolroom motion picture projection system will differ little from the systems as described in articles which have appeared from time to time in PROJECTION ENGINEERING. In fact, with proper design on control equipment the amplifier and horn reproducers as used in a schoolroom sound amplification and distribution system might be used for the projection of sound for motion pictures. Points of installation and precautions as brought out in previous articles on public-address equipment will apply equally to sound systems as designed for the projection of audible motion pictures. The quality of reproduction depends primarily upon the signal response of the entire circuit from photoelectric cell or disc pickup to the loudspeaker. If no distortion is introduced along the line and if output amplifiers and reproducer horns have sufficient capacity to handle the power, the quality will be good. It should be borne in mind, however, that the overall quality of the system may be marred by one unit which has a bad frequency response. Consequently it is of importance that units as selected for building up the system into an operating whole should have adequate response over the entire audio spectrum. Quality may be marred also by a mismatching of units. Impedances should be matched either by proper selection or by the use in impedance matching transformers. It has become common practice with some sound installation engineers to compensate for deficiencies of frequency response in the system by a deliberate mismatching of impedances, but in general better results will be obtained by the use of a tone control device. There are several excellent ones now on the market. All input and output lines should be twisted and shielded and kept far enough apart to eliminate the possibility of crosstalk.

Spare Parts

In all but the simplest of systems it will be well to furnish an auxiliary amplification system which may be held in reserve ready to be placed in service in case of failure of the main amplifier. The reserve amplifier should have the same frequency response and same power output, although it need not be of such serviceable construction. However, in systems where financial outlay



(Courtesy, Amplex Instrument Laboratories, New York)

Rack and panel used for school sound installation.

is of paramount consideration, the system may be built initially with only one set of amplifiers, space provision being made in the installation for the addition of a reserve system at a later date.

For the ordinary school auditorium such as might be used for the projection of educational motion pictures, one loudspeaker will usually be sufficient. Due to its directional properties, a horn type speaker will no doubt best fulfill requirements to the best advantage. It might be brought out at this point that, no matter how excellent the quality of the reproduced sound as brought from the system, if the horn be placed behind a heavy, closely woven screen quality will be bad as heard by the audience. The screen, in addition to its importance to the visual portion of the program, is as important a link as any in the sound system. Much of the difficulty noted in understanding projected sound in many systems is due to interference introduced by the screen placed directly in front of the horns. A "sound screen" which will introduce no interference to the projected sound should be installed.

In case of vibrational noise passing through the system, rubber pads should be placed underneath the feet of the projection machine. Vibration will oftentimes be transmitted from a source external to the building through the floor and hence to the amplifiers.

In schools of high school grade and above, there will always be some students who are sufficiently interested in motion picture projection to wish to operate the machine. These students may be trained in the principles of operation and care of the equipment and eminently satisfactory results will be obtained by the use of their services.

In conclusion it might be stated that while at the present time the production of educational films has not reached the proportions that educational exchanges are necessary, the time will no doubt arrive when such exchanges will function in much the same manner as exchanges now handling the regular entertainment films. Thus the building up of extensive individual film libraries will be unnecessary and even undesirable. Underwriters' regulations allow the keeping of 6,000 feet of film in the booth at one time. If more film is kept on hand, a specially ventilated, fireproof vault will be necessary, the specifications of which may be obtained from the Board of Fire Underwriters.

The instructive sound motion picture, with its peculiar problems of production, distribution and exhibition is bound to take its place in the educational program of the future. Its coming should be anticipated and adequate preparation made by educational authorities, motion picture producers and exhibitors and sound and projection equipment installation engineers.

An entirely new and vast field is about to open up, and it is one where there are possibilities of betterment in instructural methods and at the same time material savings in costs as compared with the present antiquated teaching methods, relics of a bygone age.

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SOUND MOVIES IN EDUCATION

IN the November issue of PROJECTION ENGINEERING will appear an article on the subject of sound-pictures in education, by Dr. Alfred N. Goldsmith, vice-president and general engineer, Radio Corporation of America. Dr. Goldsmith is a widely recognized authority on this important subject.

A moving coil microphone for high quality sound reproduction

By W. C. Jones and L. W. Giles*

A microphone is described in this paper which retains all of the inherent advantages of the moving-coil type of structure but unlike the earlier forms of this microphone responds uniformly to a wide range of frequencies. It is more efficient than the conventional form of condenser microphone and its transmission characteristics are unaffected by the changes in temperature, humidity and barometric pressure encountered in its use. Unlike the condenser microphone the moving-coil microphone may be set up at a distance from the associated amplifier and efficient operation obtained. Owing to its higher efficiency and lower impedance it is less subject to interference from nearby circuits. It is of rugged construction and when used in exposed positions is less subject to wind noise.

THE basic idea underlying the moving-coil or electrodynamic type of microphone were apparently conceived during the initial stages of the development of the telephone, for as early as 1877 the suggestion was made that the static force exerted on the diaphragm of Bell's electromagnetic microphone could be eliminated and its performance improved by making the diaphragm of non-magnetic material and attaching to it a coil, preferably of aluminum, so arranged as to vibrate in a magnetic field and generate a voltage in response to the sound pressure on the diaphragm.[1] The moving-coil and electromagnet microphones are generators and their output is limited to the acoustical power available at their diaphragms. They did not, therefore, find extensive application in the telephone field for the demand for instruments which would permit the extension of telephone service to longer distances soon led to the development and introduction of the carbon microphone which is an amplifier and can be so designed as to deliver more power to the electrical circuit. During recent years the introduction of the vacuum tube amplifier has reduced to a considerable extent the limitations imposed by the lower power output of the generator type of instrument and attention has been turned to the moving-coil microphone as means for obtaining an instrument suitable for high quality sound reproduction in connection with radio broadcasting, sound picture recording and acoustic measurements in general.[2] It is the object of this paper to describe the construction and transmission characteristics of a moving-coil microphone, Fig. 1, which has been developed for this purpose and which responds uniformly to a wide range of frequencies and is unaffected in its response by the changes in temperature, humidity and barometric pressure encountered in its use. Unlike the condenser microphone, this microphone may be set up at a considerable distance from the associated amplifier and because of its higher efficiency and lower impedance is less subject to interference from nearby circuits. It is of rugged construction and when used in exposed locations is less subject to wind noise than the condenser microphone. The use of a permanent magnet eliminated the necessity of providing a polarizing voltage.

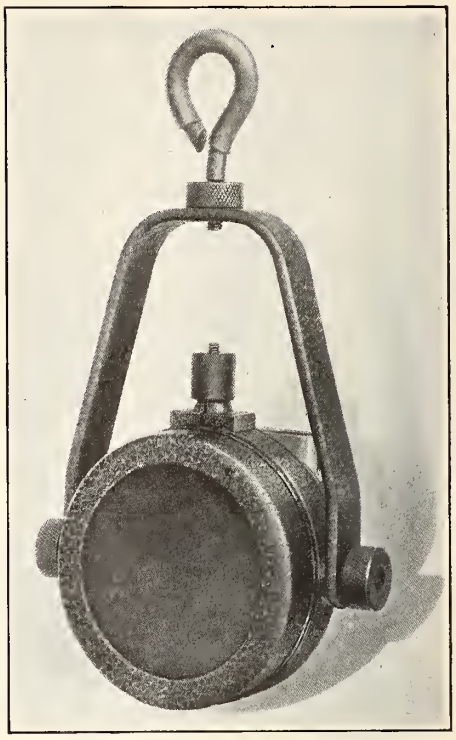


Fig. 1. Moving-Coil Microphone.

Construction of the Microphone

Although the early forms of the moving-coil microphone possessed the advantages of absence of static force on the diaphragm, substantially uniform force factor and electrical impedance over a wide frequency range, and freedom from non-linear distortion even at large amplitudes, their response varied with frequency to such an extent as to make them unsuited for high quality sound reproduction. This was due in general to two causes. In the first place the mechanical impedance of the diaphragm and coil varied widely with frequency, being high at the frequencies where the mass and stiffness reactances were the predominant factors and relatively low in the region of the resonant frequency where the mechanical resistance determined the magnitude of the impedance. Since the velocity imparted to the diaphragm and coil is directly proportional to the applied force and inversely proportional to their mechanical impedance and since

* *Bell Telephone Labs., Inc., New York City*

[1] *German Patent, No. 2355, Siemens and Halske, Dec. 14, 1877. British Patent, No. 4685, Siemens, Feb. 1, 1878. United States Patent, No. 242818, Cuttriss and Redding, June 14, 1881.*

[2] *A microphone, often referred to as the ribbon microphone, has been developed by E. Gerlach and W. Schottky in which an aluminum ribbon serves the dual purpose of electrical conductor and diaphragm. (Phys. Zeit., Vol. 25, (1924) pp. 672 and 675. Handbuch der Physik Vol. 8, (1927) pp. 552 and 578). An interesting application of the ribbon microphone as means for measuring the acoustic output of a telephone receiver is described in a paper by H. Carsten. (E. T. Z. Vol. 44 (1923) p. 257). A recent paper by B. A. G. Churcher and A. J. King (Journ. I.E.E. Vol. 68 (1930 p. 97) discusses the application of the moving coil microphone to measurement of noise.*

the voltage generated in the coil is directly proportional to the velocity of its motion in the magnetic field, it is evident that the response of such an instrument, i. e., the open circuit voltage per dyne per square centimeter pressure (bar), would vary considerably with frequency and be characterized by a prominent peak at the resonant frequency. In the second place, there was a tendency for the mode of vibration of the diaphragm to change at the higher frequencies and introduce additional irregularities in the response. In the microphone described in this paper the diaphragm has not only been so constructed as to reduce to a minimum the effect of changes in the mode of vibration, but several acoustical circuit elements have also been coupled to the diaphragm and coil in a manner such that the velocity imparted to the coil per unit pressure in the actuating sound wave is substantially uniform throughout the frequency range of 35 to 10,000 cycles per second. A cross-sectional view of the microphone and its equivalent circuit are shown in Fig. 2.

The diaphragm is made of duralumin .001 inch in thickness, and has a dome-shaped center portion which extends to the inner edge of the moving coil. This stiffens the center of the diaphragm to an extent such that it vibrates substantially as a plunger throughout the frequency range of interest. The moving coil consists of approximately 65 turns of aluminum ribbon, .001 inch thick and .008 inch wide, wound on edge and insulated with phenol varnish which also serves as a binder for holding the adjacent turns together.[3] The coil is fastened to the diaphragm with spar varnish which is baked at a temperature sufficiently high to drive off the volatile material and insure a rigid bond between the adjoining surfaces. The effective mass, (m_0) stiffness (s_0) and resistance (r_0) of the coil and diaphragm assembly are approximately .15 grams, 1.5×10^6 dynes per centimeter and 200 dynes per centimeter per second respectively.

The diaphragm is clamped around the periphery by a ring which is so designed as to reduce the cavity in front of the diaphragm to a minimum. A magnet field having a density of approximately 11,000 maxwells per square centimeter is established in the air-gap, in which the moving coil is located, by a permanent magnet made from steel containing approximately 35 per cent cobalt. The magnetic properties of this alloy are such that the size of the magnet can be reduced to a minimum and demagnetization practically eliminated.[4]

Concentric alignment of the pole-pieces is insured by welding the center pole-piece to the magnet and locating the outer one by means of pins fitted in soft iron inserts cast in the magnet.

A perforated metal grid covered with silk protects the diaphragm from injury. The grid and the metal housing of the instrument are insulated from the moving coil and form a shield which may be connected to ground through one of the three contacts in the jack mounted on the back of the housing. The other contacts form the terminals of the moving coil. In order to reduce the contact resistance to a minimum a cam has been provided which presses the contact members tightly together after the plug has been inserted in the jack. This cam also serves as a lock to prevent the plug from being accidentally withdrawn from the jack while the microphone is in use.

When the diaphragm is displaced, there is an interchange of air between the cavity formed by the diaphragm and pole-pieces and that enclosed by the housing. The connection between these cavities is a slot at the base of the coil which has dimensions such as to introduce a mechanical resistance (r_2) of approximately 3,000 dynes per centimeter per second and a mass (m_2) of approximately .10 grams. As is shown in Fig. 2 this slot is formed by clamping the projecting portions of a .0026-inch shim between a ring and the outer pole-piece. The dimensions of the ring are such as to provide clearance between its inner diameter and the center pole piece. Acoustic leakage at this point is prevented by a rubber gasket which seats on a shoulder on the center pole-piece and presses against the ring when the instrument is assembled. The resistance and mass of the slot and the stiffness of the cavity enclosed by the housing (s_2) are coupled to the diaphragm by the stiffness of the cavity between the diaphragm and pole-pieces (s_1). The cavity stiffness s_1 and s_2 are approximately 160×10^6 and $.5 \times 10^6$ dynes per centimeter respectively. Unless otherwise specified the values of stiffness, resistance and mass in this paper are given in mechanical units effective at the diaphragm. The introduction of the mesh ($r_2m_2s_2$) practically eliminates the prominent resonance peak to which reference was made in the discussion of the response of the simple microphone in which the mass, stiffness and resistance of the coil and diaphragm are the predominant factors in determining its mechanical impedance.

Although there are certain uses to which a microphone is put where the conditions agree quite closely with those assumed in the pressure calibration, as for example, when it is coupled directly to another instrument as is often done in the calibration of a telephone receiver. If, on the other hand, the microphone is placed in a sound field of uniform intensity the pressure acting on its diaphragm may depart widely from a constant value in certain frequency ranges, the magnitude of the departure depending not only upon the microphone itself, but also upon the nature of the sound source, the position of the microphone relative to the sound source, the configuration and acoustic properties of the reflecting surfaces which surround the microphone, etc. If the microphone is so located relative to the source of sound that the direct waves predominate and standing waves are not set up between the microphone and the source,

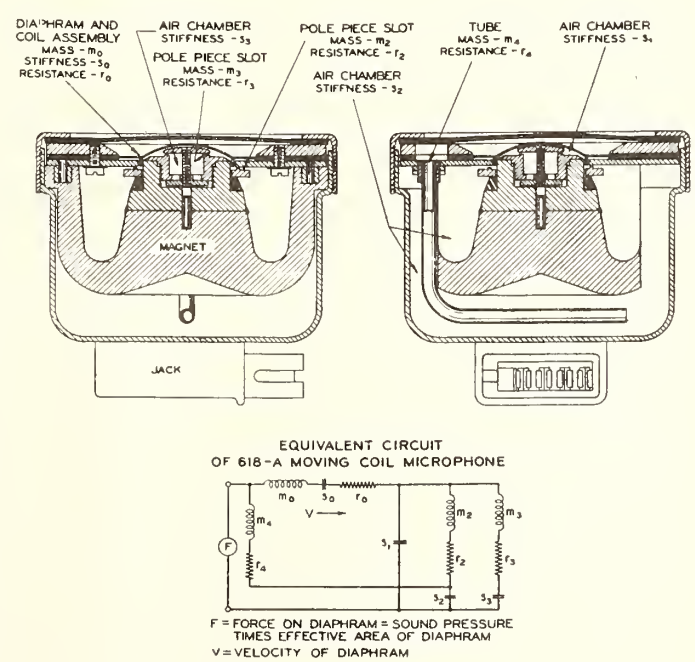


Fig. 2. Cross-section moving coil microphone.

[3] *High Efficiency Receiver of Large Power Capacity, E. C. Wente and A. L. Thuras, Bell System Technical Journal, Jan. 1928, pp. 140-153.*
[4] *K. S. Magnet Steel. K. Honda and S. Saito, Physical Review, July, 1920, pp. 495-500.*

the response will usually agree with the normal incidence field calibration. The acoustic conditions in most indoor work are, however, such that much of the sound reaches the diaphragm of the microphone by way of reflection from walls and surrounding objects with the result that the direction of approach of the sound cannot be considered as normal to the plane of the diaphragm and the characteristics of the reflected sound are modified by the acoustic properties of the reflecting surfaces. Under these conditions the effective angle of incidence is somewhere between 0 and 90 degrees. The acoustic conditions encountered in the practical use of a microphone vary so widely that any one response curve cannot be considered as representative of its performance under all conditions of use. This is even more evident when it is recalled that the data from which curves were plotted were secured after steady state conditions had been established. It is obvious, therefore, that, although the response curve serves a useful purpose in indicating the sort of performance to be expected with a given instrument, it must be interpreted in light of the conditions which exist in each individual application. If the microphone is to be used for precise quantitative acoustic measurements a calibration should of course be made under the actual conditions of use.

The mechanical impedance of the moving-coil microphone is so low that the stiffness of the cavity required to obtain a satisfactory calibration by the thermophone method has a marked reaction on the response obtained.

Effect of Changes in Temperature, Humidity and Barometric Pressure

The response of the moving-coil microphone is independent of the changes in temperature which are likely to be encountered in its use. In reaching this conclusion response data were secured at temperatures ranging from 50 degrees below zero to 130 degrees above zero, Fahrenheit. The maximum deviation from the response at room temperature observed during these tests was of the order of 1.5 db. Differences of this magnitude are within the precision of the test.

The tube which was introduced to improve the response at the low frequencies also provides means for equalizing the pressure in front and back of the diaphragm and eliminates the effect of changes in barometric pressure on the response of the microphone.

During the development of the moving-coil microphone representative samples were tested for the effect of humidity by placing them in a room in which the relative humidity of the air was maintained at 90 per cent. No change in the transmission characteristics of the instruments was observed after they had been subjected continuously to these rather severe atmospheric conditions for a period of five days. All of the metal parts are protected from corrosion by suitable finishes.

Wind Noise

Laboratory tests for wind noise show the noise level of the moving coil microphone to be approximately 6 db. lower than that obtained with the 394 type condenser microphone at wind velocities of 20 to 30 miles per hour. At lower velocities the difference is from 5 to 10 db. greater.

Conclusion

Although there are certain desirable characteristics, such as absence of static force on the diaphragm, constancy of force factor and electrical impedance, freedom from nonlinear distortion, etc., which are inherent in the moving-coil type of microphone, the response of the earlier forms of this instrument varied to such an extent with frequency as to make them unsuited to high quality sound reproduction. It has, however, proved feasible to retain the desirable characteristics of the moving-coil structure and secure substantially uniform response over the frequency range of 35 to 10,000 cycles per second by associating several acoustical impedances with the mechanical impedance of the diaphragm in the manner described in this paper. During the development of this microphone consideration was also given to reducing its size sufficiently to make its response, throughout this frequency range, independent of the angle of incidence and diffraction of the sound wave, but the transmission and structural difficulties encountered proved prohibitive. External dimensions and acoustical and mechanical constants were, therefore, chosen for the instrument such that its response at the frequencies, where diffraction and angle of incidence are of importance, is substantially uniform under the conditions most likely to be encountered in its use. In this connection it should of course be borne in mind that the response obtained is not only dependent upon the characteristics of the microphone, but also upon the nature of the sound source, the position of the microphone relative to the sound source, the configuration and acoustical properties of the reflecting surfaces which surround the microphone, etc., and that data relative to the response of a microphone must in each instance be interpreted in light of the conditions under which it is to be used.

The efficiency of the moving-coil microphone described in this paper is approximately 10 db. higher than that of the 394 type condenser microphone and its transmission characteristics are unaffected by the changes in temperature, humidity and barometric pressure likely to be encountered in its use. It can be set up at a considerable distance from its associated amplifier and efficient operation obtained, and is less subject to interference from nearby circuits. It is of rugged construction and when used in exposed locations is less subject to wind noise than the condenser microphone.

A number of moving-coil microphones of this type are now in use and the results obtained are in general in agreement with the conclusions reached in this paper.

We are indebted to Messrs. T. E. Davis, R. C. Miner, W. C. Jones, W. L. Gells and R. N. Marshall of the Bell Telephone Laboratories for much of the material used in this paper.

EXAMINATION QUESTIONS FOR PROJECTIONISTS

THE following ten technical questions are submitted to projectionists. Each month an additional list of ten questions will appear. Projectionists who wish to regard this series of questions as an examination may forward to the editor their answers.

The correct answers to each list of ten questions will be published in the issue of PROJECTION ENGINEERING one month after the questions are submitted.

The names of those correctly answering the questions will be published except in cases where those sending in answers request that their names be not given out.

Get ready for the difficult questions to appear in later issues.

The Questions

1. What is a sound pickup (a) as used on sound-on-disc, (b) as used on sound-on-film?
2. What is meant by "synchronous current?"
3. How would you test the specific gravity of a storage battery?
4. State how you would test amplifier equipment, prior to the day's showing?
5. What is meant by the term "torque?"
6. State three causes of loss of volume (sound-on-film) and what you would do to check and remedy same.
7. State what would cause loss of volume, when using sound-on-disc.
8. If you lost sound during the show where would you look for trouble?
9. What is a two-phase motor?
10. Which travels faster, sound or light?

New uses for the thermocouple

A NEW type of thermocouple potentiometer has been announced by the General Electric Company for accurate temperature measurements. Designated as Type PJ-1, the instrument works on the principle of a fixed current through a variable resistance, the unknown e.m.f. being balanced against the voltage drop of a variable current through a fixed resistance. The reading is then obtained by measuring the current with a Type DP-2 instrument. The principle overcomes the need for a standard cell, which requires frequent balancing to make certain the potentiometer current has not varied.

The scale of the 500-microampere Type DP-2 instrument reads up to 6 millivolts. A switch multiplies the scale values by one, 5 or 10, thus making full-scale values of 6, 30 and 60 millivolts. There is also a temperature scale reading from 0 to 140 degrees Centigrade, for use only when the G. E. copper-Copnic thermocouple is used with the 6-millivolt scale.

A cold-junction compensator knob, mounted on the metal cover of the microammeter, is used to set the needle at a temperature or millivolt value corresponding to the temperature of the cold junction. A thermometer is mounted on the panel to determine the cold-junction temperature when an ice bath is not used and the potentiometer is being used without a transfer switch. A battery switch on the panel is used to open the battery circuit and thus avoid deterioration of the battery when the instrument is not in use.

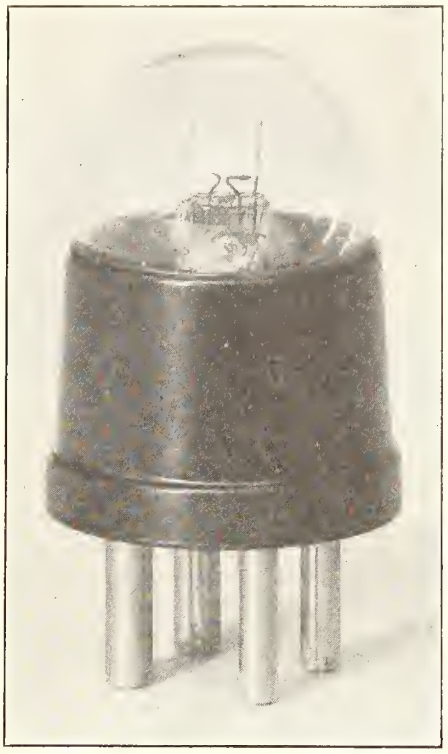
The potentiometer case, of walnut, measures 12 by 9 by 16 inches. Two flashlight dry cells are mounted in the bottom; all other parts are on the panel.

The potentiometer is self-contained for use with a single thermocouple, but when measurements are to be made with a number of thermocouples a transfer switch is used. A transfer switch has 20 pairs of terminals, all mounted in the top of a panel, making it possible to have all the internal connections of rigid, short heavy leads. The live contacts are separated by blank contacts, making it impossible to short-circuit adjacent thermocouples. Copper wires are used for connections between the transfer switch and the potentiometer. The cold junction temperature is read from the thermometer in the transfer switch.

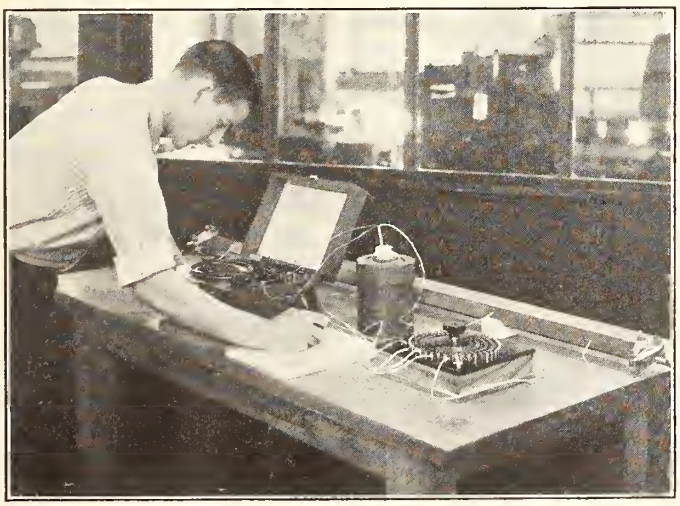
For precision temperature work an ice bath is used for cold junction temperatures. One ice bath between the transfer switch and potentiometer is sufficient for all thermocouples.

The positive wire of the thermocouple is of copper; the negative wire is of Copnic (nickel, copper, iron and magnesium). The thermocouple is accurate within a half degree between 0 and 150 degrees Centigrade. Each wire is enameled and insulated with cotton, then cabled with a cotton insulation, and further protected with white, flame-proof paint.

A vacuum thermocouple for a-c. readings, and a new type of potentiometer.



Vacuum thermocouple mounted in UX base.



G. E. Type PJ-1 thermocouple potentiometer being used to measure temperature of copper bar. Transfer switch at right.

Vacuum Thermocouple for A-C. Readings

By means of a new vacuum thermocouple, announced by the same company, it has become possible to measure accurately alternating current of any frequency with a sensitive direct-current instrument. The copper-oxide rectifier, ordinarily employed for such measurements, is less sensitive, cannot be used with current of high frequencies, and its accuracy is seriously affected by the waveform of the alternating current being measured.

The thermocouple consists essentially of a heater wire and small thermocouple sealed in a vacuum bulb. The voltage developed in the thermocouple by the temperature rise of the heater wire, which is read on the direct-current instrument, bears a definite relation to the current in the heater wire.

The device is contained in a tipless lamp bulb with a four-prong UX-type base. It can be mounted in portable instrument cases where a space only 1½ inches in diameter and 2 inches deep is available. The thermocouple can also be furnished in a metal container with a wooden base and cover, to shield it from light and from sudden temperature changes when it is to be used externally.

Frequency errors in the audio-fre-

(*Concluded on page* 16)

High power for the public-address system

By C. H. W. Nason

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Availability of mercury-vapor rectifier simplifies construction of outdoor sound system.

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WHILE the power output of two—45 tubes in push pull—or of two —50's will serve to cover the interior of a small auditorium it is necessary to employ much higher power to obtain coverage of an equal area in the open. Installations for dance-halls, race tracks, picnic grounds or in other locations of similar character require much greater power than can be achieved even with multiple installations employing several small amplifiers. It is the writer's purpose to describe a high power amplifier capable of serving large outdoor gatherings or large interiors but which remains within the constructional capabilities of the average technician.

The availability of the DeForest 545 amplifier tubes and the new 566 mercury vapor rectifiers place the construction of such an installation within the range of every competent engineer familiar with the smaller amplifiers now in common use. The unit to be described is a single integral push-pull stage feeding in and out of a 500 ohm transmission line. The undistorted power output available is in excess of fifty watts—enough to serve any required number of dynamic reproducers.

The characteristics of the design are such that the average small amplifier, say a pair of small —45 tubes in push-pull preceded by a single —27 will more than furnish the requisite input even where a microphone is employed. Using this type of input amplifier with a phonograph pickup will necessitate the use of a certain amount of care if the 50-watt stage is not to be overloaded. To this end it will be noted that the input to the amplifier is broken by a "T" pad so that the input can be limited to a safe level.

The 566 rectifier tubes are of the new, mercury vapor type and it is essential that their filaments be allowed to attain proper operating temperature before the plate voltage is impressed. If the destruction of the tubes is to be avoided this precaution is not to be taken lightly. The resistance from plate to filament of the tubes is but a few ohms at the operating temperature and the heat losses are quite small. If, however, the plate voltage is applied to the tubes before the proper operating temperature has been reached destruction of the tubes and possibly of the power transformer will result. It is for this purpose that the two power switches are provided. There are time delay relays on the market which will take the place of manual operation of the two switches. The Ward-Leonard Company makes a "self-recycling" model which may be cut off and on again during the sixty second delay period without limiting the time delay if switched on again immediately. It is also an essential consideration that the full 2.5 volts specified be applied to the tube filaments.

The constructional and operating details are no different from those involved in smaller amplifiers although it is necessary that the balance between the tubes be accurate if long life is to be secured. The split secondary of the input transformer is balanced to ground by means of a 400-ohm potentiometer which should be adjusted so as to even up the plate current swing of the tubes during operation. Loss of emission of one of the tubes will be evidenced by the use of two plate current meters mounted on the panel.

Investigation of the power supply circuit will show that the input to the filter is through a choke rather than across a condenser as is usual. Choke input to the filter allows for the use of a less expensive type of power transformer, improves the regulation of the power supply system and protects the rectifier tubes from breakdown. It also makes possible the use of much smaller filter condensers without danger of breakdown due to surges.

The installation as shown schematically in Fig. 1 will make an excellent job for theatre, auditorium or outdoor use wherever a high quality channel of the power involved is desired. The two amplifiers may be remote from one another and connected by ordinary twisted pair.

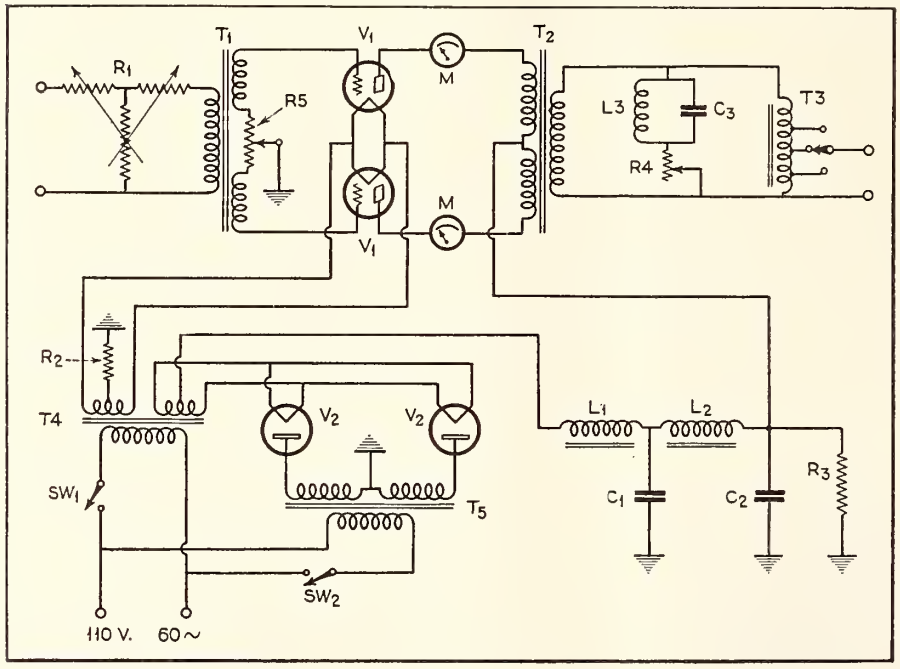

Fig. 1, M—Weston model 301 meter 0-100 ma.
Sw1 and Sw2 power switches preferably having integral pilot lamp. Sw2 may be replaced by time delay relay having a period of 60 seconds.
T1—Amertran 3664 transformer—500 ohms to grids.
T2—Amertran 4116A transformer—from 545 tubes to 500 ohm line.
T3—Amertran auto transformer—No. 3377—500 ohms to .16 to 16 ohms.
T4—Amertran filament transformer H4201, 10 volts 6.5 a. and 2.5 volts 10 amperes.
T5—Amertran plate transformer 4656—2360 volts center tapped.
L1 and L2—Amertran 557A chokes.
L3, C3 and R4—Equalizer circuit for improving h-f. response—5 millihenrys (300 turn honeycomb coil), 0.2 mfd., and 400 ohm potentiometer.
V1—De Forest 545 Audion.
V2—De Forest 566 mercury vapor rectifier.
R1—Electrad TS 500 "T" pad.
R2—Electrad 1,000 ohm resistance type D-10.
R3—Electrad 50,000 ohm resistance type D-500.
R5—Electrad 400 ohm potentiometer.
C1 and C2 Aerovox 2 mfd. 2000 volt condensers.

Indoor applications of air-column horns

By C. J. Brown*

GREAT strides have been made in the design of air-column horns since the introduction of the sound motion picture. This new art has proven beyond doubt that the horn is supreme for indoor as well as outdoor sound systems and field experience in public-address work has shown that where local microphone pickups are to be made the horn, with its controllable projection, is an absolute necessity if maximum efficiency is to be realized. There are two principal characteristics of a horn which it is desirable to know for the proper application thereof. These are: (1) the projective power of the horn, and (2) its diffusion angle.

By projective power we refer to the inherent property of a correctly designed straight air-column to allow an initial sound impulse at the throat to travel along the column and out of the bell, without diminishing velocity or distorted wave-front (causing any part of the wave-front to lag behind any other part). The six foot trumpet horn illustrated in Fig. 1 represents the commercially perfect projector and its projective power is well known. A single trumpet with a Giant dynamic unit has actually been heard at a distance of a mile and a half. Since the air-column is straight, long and properly tapered, the initial sound impulse from the dynamic unit expands naturally as it travels along the column, maintains a plane wave-front and leaves the bell without distortion or lag. This explains the superb quality obtainable from this particular type horn.

Fig. 1.

In an outdoor auditorium it is evident that while we must have high quality, such tremendous projective power as that of the straight trumpet is wholly unnecessary and would create too much reflection for microphone use. Indoor lengths seldom exceed 300 feet, and if they should, the horn problem should be submitted to the manufacturers for expert advice. There are also practical installation difficulties in the way of using a straight horn. Therefore the reason for the coiled type.

When an air-column is coiled, the projective power is reduced and extreme coiling reduces it beyond the point of usefulness. Thus to design a coiled horn properly is a fine problem, since to get low-frequency response the effective bell-area must be large, with proper rate of taper. But if the long air-column is sharply coiled, considerable projective power is lost, and due to the variation in velocity between the upper and lower sides of the wave-front as the sound impulse travels along the coiled path the wave is not projected in a plane parallel to the face of the bell. The bottom of the wave actually leaves the bell before the top, making for poor projection and distorted reproduction. To remedy this condition it is necessary first to avoid sharp bends, and to so design the horn that the wave-front restores itself to a plane path of travel, thereby expanding to an area that will give high quality with good low-frequency response.

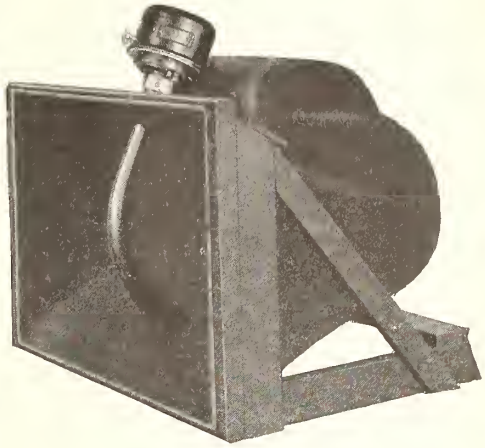

Fig. 2.

The diffusion angle of the horn may be defined as that angle of space in front of the bell, in which the intensity of the sound will not vary more than 3 db. at any point on an arc across that angle. Beyond the sides of this angle the intensity drops sharply and for practical applications is not considered as useful. It is thus evident that knowing the diffusion angle of the horn it is simple to place the horn or horns so as to cover a definite area *with a definite intensity*. In a practical way this characteristic of the air column horn is of immense value because in microphone systems the horns can be placed and directed at such angles as will minimize the effect of a return wave and avoid microphone feedback. The writer has never seen an auditorium where the use of an air-column horn did not improve many times the efficiency and operating qualities of a microphone system.

We shall now explain how the requirements of high quality with proper diffusion and projective power have been correlated in various commercial horns that will meet practically any acoustic problem.

Fig. 2 illustrates (332ON) a coiled horn with a seven and one-half foot

Fig. 3.

Engineer, Racon Electric Co.

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It depends upon the conditions, what type of loudspeaker horn should be employed. In this article the type of horn to be used under given conditions is described and illustrated.

air-column. The air-column is long, and the coiling is so arranged and the horn is so designed that the wave-front straightens itself before reaching the bell. This horn gives remarkable speech reproduction with wide diffusion and considerable projective power. The bell is oval, and expands in an unusual manner and has a very wide angle of diffusion—60 degrees. Thus for a fairly long auditorium of medium width (approximately one-third of its length) and where speech alone was to be reproduced, this horn would render excellent service. This horn can of course be used for both speech and music, but the above example is intended to illustrate its proper application to a specific problem.

Where both speech and music are to be reproduced, in an auditorium which is not too long compared to its width, the horn in Fig. 3 (No. 2115) can be used with excellent results. This horn has a very long air-column, but has such a rate of expansion and curvature that even though the bell area is small, the frequency response is broad and particularly good at the low end. Its diffusion angle is 45 degrees and it is evident that two of these horns should be used in most applications.

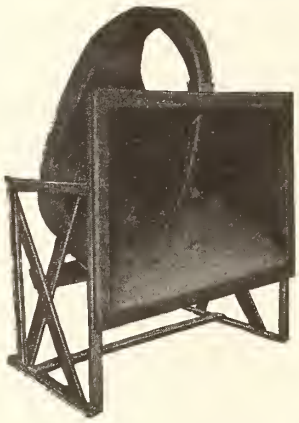

Fig. 4.

When we come to very large auditoriums seating two to ten thousand people, the design of which approach the theatrical, the horns of the type shown in Fig. 4 are used. They combine long air-column with minimum curvature and a large bell area. Their quality of reproduction is unsurpassable, but as the diffusion angle is low, about 40 degrees, it is also usually necessary to use two of these horns.

Fig. 5 illustrates an interesting type, the wide angle horn. It has a ten foot long air-column, a very slight air-column curvature and an extraordinarily large and wide bell area. The diffusion angle is 100 degrees and it can be readily seen that one of these horns is sufficient for the extremely wide auditorium.

An installation of one of these horns was made in an auditorium, three hundred feet long and 150 feet wide, having a wide balcony all around, seating 9,000 persons. The horn was placed *twenty feet above* the microphone, with excellent results.

Finally the size of dynamic units to use on these various horns is a very important requirement, both for economy and efficiency.

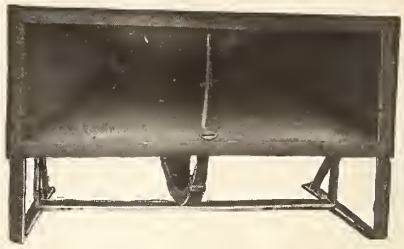

Fig. 5.

The type to use is generally dictated by acoustic conditions, in each case. For example in an all stone or concrete auditorium such as a church or gymnasium, it will not take much power when reproduced through an air-column horn to cause excessive reverberation. Therefore, the smaller units, particularly for speech only, can be advantageously used. If, however, the audience is very large, and it is practical to mount the horns high above the floor, then the large units meet every situation efficiently. It is useful to remember in using a dynamic unit type reproduced with air-column horn that the efficiency is many times that of the conventional mechanical reproducer and it is not necessary to use the extremely heavy powers, otherwise required.

It can be seen that with the large number of horn types available, together with the various sizes of dynamic units, it is possible to meet every requirement of public address installations, efficiently and economically.

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S. M. P. E. NOMINATIONS

NOMINATIONS for all offices in the Society of Motion Picture Engineers have been made and acceptances have been received from the nominees. Ballots have been mailed to all active members of the Society and results of the election, now being held by mail, will be announced at the Fall Meeting of the Society, to be held at Swampscott, Mass., October 5-8.

Dr. A. N. Goldsmith, vice-president and chief engineer of the Radio Corporation of America, and Dr. V. B. Sease, director of research, Dupont-Pathe Film Manufacturing Company have accepted their nominations for president. E. I. Sponable, director of research and development, Fox Film Corporation, and M. W. Palmer, electrical engineer, Paramount Publix Corporation, are the nominees for vice-president.

Other nominees are as follows: J. H. Kurlander, commercial engineer, Westinghouse Lamp Co., and R. E. Farnham, commercial engineer, General Electric Company, for secretary; H. T. Cowling, Eastman Kodak Company, and W. B. Little, engineer in charge of photometry, Electrical Testing Laboratories, for treasurer; L. C. Porter, illuminating engineer, General Electric Company, W. H. Carson, vice-president, Agfa Ansco Corporation, W. B. Rayton, director of scientific bureau, Bausch and Lomb Optical Company, and O. M. Glunt, assistant director of apparatus development, Bell Telephone Laboratories, for members of the board of governors.

J. I. Crabtree, who retires as president after holding this office for two years, has declined a renomination.

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NEW USES FOR THE THERMOCOUPLE

(*Concluded from page* 13)

quency range (up to 10,000 cycles) can be neglected in using the instrument. For the best accuracy in the radio frequency range, the couples should be unmounted. In most cases, the thermocouples are sufficiently accurate on dirent current without taking the average of direct and reversed readings.

There is little change in the calibration of the thermocouple if the maximum safe current is not exceeded. The thermocouples are designed to give maximum watts output with minimum watts input to the low resistance heater.

Electrical Data

The approximate constants for each type of the Type A vacuum thermocouple are shown in the table herewith. The millivolts are for the open-circuit couple voltage; the maximum heater current is the maximum safe continuous rating; and the fusing current is the approximate current required to burn out the heater in less than one minute.

Type	Ohms Heater	Ohms Couple	Heater Milliamps. For 5 mv.	15 mv.	Maximum	Fusing
A-2	14	14	13	25	40	100
A-3	400	14	2	4.5	8	100
A-4	40	14	5.5	10	20	40
A-5	5	7	25	50	100	275
A-6	2.5	7	55	110	200	450
A-7	1	7	125	250	400	900
A-10	800	14	1.3	2.9	4	30

From the table of resistances and open-circuit couple volts, the proper couple can be selected to give the required range of the galvanometer or instrument with which it is to be used, the resistance and current range of the indicator being known.

Monitoring and sound control in theatres

O. M. GLUNT
Chairman, Papers Committee S.M.P.E.

IN the report of the Projection and Sound Reproduction Committee of the Society of Motion Picture Engineers, which was presented in abstract before the society at Washington, and in full before the New York Section, June 12, 1930, there appeared a section on adjustment of volume levels and remote control. This report dealt principally with methods of controlling volume directly by an observer in the auditorium. As a matter of fact, there are now devices on the market which permit such control. Whether the use of these devices has proved effective is not clear, but the fact remains that there is a general urge to investigate fully the whole problem of volume control.

There are three distinct systems for providing volume control for theatres:

(1) The method most generally in use which, to be effective, requires an observer in the audience who signals the projectionist for volume change.

(2) The method described in the above report which provides actual control of volume by the observer in the audience.

(3) A method which attempts to give to the projectionist some means of knowing what volume of sound is present in the auditorium, from which means he can adjust the volume from the projection booth.

Before discussing the advantages and disadvantages of these three methods, we may observe:

(*a*) The present monitor horn functions reasonably well for the purposes for which it was intended, namely, (i) means of checking the sound system before the start of a show, and (ii) maintaining a running check of the system during its operation.

(*b*) It seems evident that from a theoretical standpoint the best location in which to hear the results obtained in the auditorium is in the audience itself. An observer placed in the audience hears just what the audience hears, can take into account the audience's reaction, and note the effect of the changing number of people, which in many houses materially affects the sound absorption, etc.

System (1)

System (1) is based on the theory that the actual volume control should be handled by the projectionist, and further, that the proper place to judge volume is in the auditorium itself. This system, therefore, has two more desirable features. The disadvantages are:

(*a*) A slight time lag between the giving of a signal by an observer in the audience and the volume adjustment made by the projectionist.

(*b*) The increased expense of having an observer in the audience.

(*c*) A chance of carelessness on the part of the observer or on the part of the projectionist which will result in poor operation.

(*d*) The arrangement being described anticipates a rehearsal before the opening of the show. With the new release print in vogue, the need of such a rehearsal is less since the change-over cues are automatically indicated.

To refute these objections it might be said of (*b*) that a first-class house can well afford such an observer (who would be absolutely essential to system (2) which is to be described below), and furthermore, that a small house which could not afford an observer could probably not afford additional monitoring equipment unless it were very cheap. Additional equipment requires maintenance and usually the cheaper the equipment the greater the maintenance.

Item (*c*) anticipates carelessness on the part of the personnel, but no matter what system is employed carelessness results in a poor show.

Item (*d*) is included under carelessness because if the manager is alert a rehearsal should be demanded even if only for sound cues.

System (2)

System (2) indicates actual control of volume by the observer in the audience. This system has the advantage of reducing time lag to a minimum and permits the control to be handled in the audience, which is the best position for such observations. The disadvantages are again, the additional expense in providing an observer and the absolute necessity that this observer must always be present, for if he is not, the entire method is not workable. It might further be observed that the man in the audience must have knowledge of the capabilities of the system itself, otherwise he may overload the amplifiers in attempting to override audience noise during periods of applause or laughter. The best arrangement of this system calls for remote control of the fader because if the audience control is simply an auxiliary to the fader in the projection room it produces additional loss in the amplifier system which may be disastrous if perchance the amplifier system gain is only sufficient to meet normal operating conditions. There is, furthermore, a tendency toward split responsibility, which is not ideal.

System (3)

System (3) anticipates that the projectionist may have some means of knowing what is taking place in the auditorium, so that he may have entire control of volume adjustments. Any such system will obviously be more elaborate and costly than either of the other two systems described, and whether it will be more effective and usable is doubtful.

There are several methods proposed to accomplish system (3):

(*a*) One system provides a microphone, or several scattered microphones, connected to an amplifier and then to a loudspeaker located in the projection room.

The advantages are claimed to be that with a microphone in the audience the sound from the horns can be picked up and the projectionist can then know

what sound is being received in the auditorium. In other words, the projectionist's ear has in a sense been extended into the auditorium proper.

It must be remembered, however, that it will be necessary to calibrate very carefully the over-all gain of the amplifier system so that the sound in the projection room will definitely indicate whether the volume in the house is lower or higher than it should be. If anything goes wrong with the equipment so that the over-all gain is changed, the results obtained in the monitor horn will not indicate the true condition. Furthermore, the microphone will not completely reflect the effect caused by the changing number in the audience. Any effect from noise in the projection room which now hampers good hearing with the present monitor would also apply even to a greater extent to the proposed system.

(*b*) A second method proposed makes use of a microphone or several scattered microphones in the auditorium connected through an amplifier into a volume indicator.

The advantage here would be that a visual indication is presented to the projectionist which would not in any way be affected by the noise in the projection room.

There are several disadvantages. To make the system effective there should be an optimum point of operation indicated on the meter of the volume indicator with maximum and minimum points shown, above or below which the sound should never be allowed to go. The difficulties in designing such a meter and accompanying circuit are extreme. Furthermore, noise picked up from the audience, such as laughter or applause, immediately indicates increased volume on the meter. In present-day projection rooms, which are fairly well sound-proofed, a projectionist might conceivably react in such cases by believing that the sound volume through the horns is too loud and, as a result, he may reduce the gain of the amplifier system when it really should be raised. Again, a very careful calibration would have to be made in order that the indicator would give a reading of true conditions. If any of the constants of the circuit should change, an incorrect indication would result, with corresponding improper sound volume in the house. Likewise in this case, as under item (*a*), the microphone will not definitely take into consideration changes in the number of persons in the audience.

(*c*) A third method has been suggested, using a headset instead of the loudspeaker in the projection room. This has such obvious disadvantages from an operation standpoint that there is no need for discussion.

Conclusions

It is the opinion of the committee that:

(1) The proper and best place for observance of volume is in the auditorium among the audience.

(2) Any manually operated volume control system requires that the observer be trained to judge proper volume in the auditorium.

(3) There is not at present time any mechanical or electrical device which will give to the projectionists any satisfactory means of judging volume.

(4) With the observer stationed in the auditorium it should be recognized that the responsibility of the projectionist in controlling volume is only to react to the observer's signals promptly and diligently.

(5) Until some other means not now apparent are provided, the present system of volume control, as now installed in the majority of theatres, is the most satisfactory. This system provides signaling means for the use of an observer in the auditorium to inform the projectionist when to raise or lower volume and assumes a competent observer and painstaking projectionist, which are requisites for a good performance in any and all cases.

(6) It is of the utmost importance that the manager be made to realize that the responsibility for obtaining good sound reproduction is primarily his own responsibility. He must provide at all times a trained observer, whether it be himself or some one appointed for that purpose. He must educate himself to know whether the sound system is working properly and that the projectionists are responding to the signals of the observer.

(7) Regardless of where the volume control mechanism is operated, it would be advantageous that the projectionist be able to hear what is taking place in the auditorium. It is urged that efforts be continued to make such means possible.

LIGHT AND SOUND PROJECTION IN EDUCATION

In the September issue of PROJECTION ENGINEERING *we had an editorial on the subject of light and sound projection in education which elicited much favorable reaction. The article in this (October) issue, on this same subject, by Gordon S. Mitchell, will be widely read by engineers, manufacturers and by members of committees that are studying the subject of reform in educational procedure and systems.*

Subcommittee on Projection Room Routine and Maintenance

(1) With the introduction of sound apparatus into the theatres, the responsibilities of the projectionist have been greatly increased. The theatre owner's investment also has risen proportionately. It is to the mutual interest of both owner and projectionist that the fullest measure of value be extracted from each and every item of equipment (consistent, of course, with the quality of the performance, which must always be the first consideration).

(2) The committee feels that a detailed account of each and every item of work performed by the projectionist will not be of much practical value as such details vary greatly with each installation and type of performance. The committee, however, desires to outline a general system of routine which will illustrate the close attention required for the proper functioning of equipment and for the perfect presentation of sound film entertainment.

(3) A printed form should be provided for the projectionists' daily report. This form should include space for entering each film or other subject included in the performance, and blank columns for entering the starting time of each subject on every performance. It should include the names of the projectionists on duty, with the starting and finishing time opposite each name. Spaces for reports as to the condition of film, the condition of equipment, supplies needed, supplies received, irregularities and imperfections of performances should be provided, in addition to space for records of vacuum tubes put in service or removed and the number of hours of use at time of removal.

(4) This form may be made in duplicate, one being retained in the projection room and the other being sent to the manager.

(5) It is fully as important to retain a record of the projection room as it is with every other branch of the business. By keeping this daily record accurately, both manager and projectionist can readily determine conditions of equipment and supplies. In many cases they are thus able to eliminate waste.

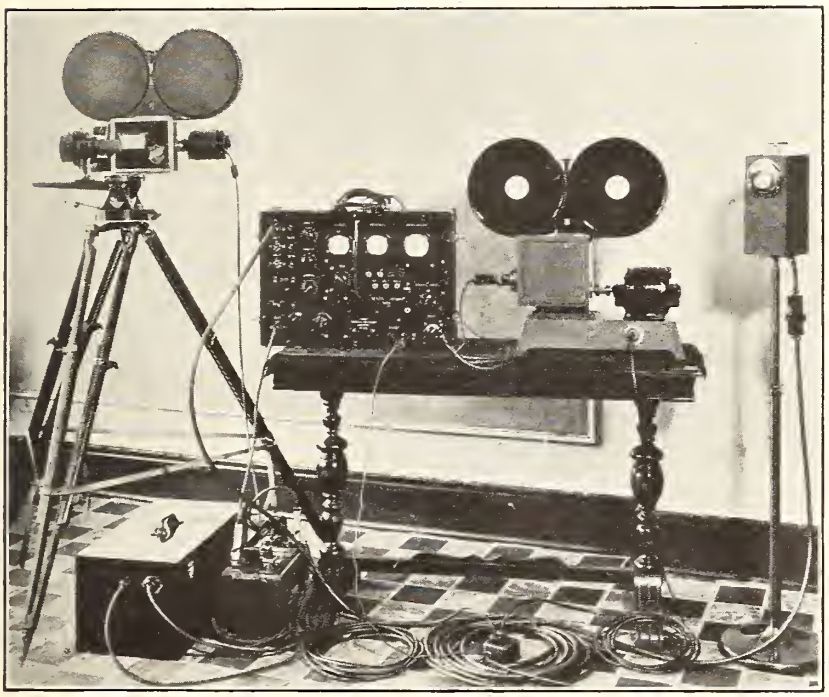
(6) Projectionists should report each day, sufficiently in advance of the scheduled opening time of the performance, to make the necessary horn and other tests of projection and sound equipment; to ascertain if batteries are in proper condition; observe meter readings; check projectors for equal volume; remove from charge such batteries as are intended for immediate use at least one-half hour prior to such use; and observe condition of vacuum tubes.

(*Concluded on page 20*)

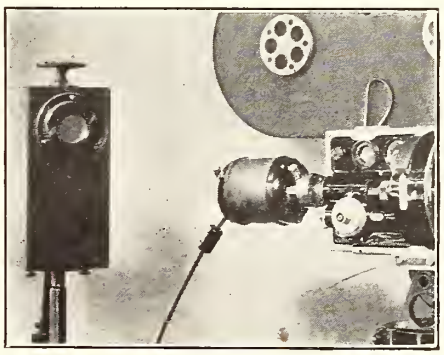
Ballyhoo plays no part!

THE CANADY RECORDER IS SOLD ON ITS MERIT ALONE

ACTUAL experience after many years of endeavor in the Sound Picture Industry have been moulded into the design of the Canady Recorder. No expense in workmanship or material has been spared, yet in price, it is within the reach of all. No Ballyhoo, no rash promises are set up for our equipment—it is marketed and sold purely upon merit and performance in line of service.



Adaptable to any type light valve, either tube or mechanical, furnished with either synchronous or interlocking motors, a complete unit in every detail. Fine condenser microphones and precision film reproducing heads for re-recording purposes are furnished with either type motor drive. The illustrations shown clearly point out the complete apparatus, camera, amplifier, microphone, recorder, cable, etc.



For technical information, prices, etc., write, wire or cable at our expense.

CANADY RECORDING EQUIPMENT COMPANY

714 Leader Bldg. Cleveland, Ohio

(7) They should consult the schedule of performances, noting particularly any deviation from previous schedules; consult the bulletin board for information or cues left by other members of the projection staff; clean interior of lamps, arc contacts, reflectors, condensers, objective lenses, and fader; and examine arc leads for corrosion and test connections for tightness.

(8) They should lubricate the projectors and let them run for several minutes, noting whether they maintain an even speed of ninety feet per minute; stop projectors, clean film trap, sprockets, and fire rollers, and wipe excess oil from bearings to prevent accumulating oil on film; check projector mechanisms for proper tension of pads, for proper clearances of pad rollers, fire valves, and film trap, and for tightness of all set screws of connectors.

(9) They should then check the exciting lamps for discoloration, condition of filament, and proper line-up; see that the sound optical system is free of oil; rewind and examine film. If new program, rewind and examine film prior to first showing, observe if changeover marks are properly placed and if any defect, such as oil accumulations, scratches, buckling, strained or broken sprocket holes are apparent. Such defects should be reported immediately.

(10) Such parts of projection and sound equipment as do not require daily cleaning, lubricating, or inspecting should have a designated day of the week assigned for receiving such attention.

(11) The procedure as outlined above, if properly carried out, will guard against film damage. Faulty adjustments or worn parts will cause film damage—a cause of great loss to the industry. Film in bad condition, faulty adjustments, or worn mechanisms create possibilities of film fire, with its attendant danger and financial loss.

(12) In projecting picture or effect, the projectionist should strive to avoid imposing any distraction on the audience which would serve to destroy the illusion, such as flickering light, shaking or moving the projected image.

(13) He should be constantly alert in maintaining even illumination, sharp focus, smooth changeovers, and proper timing of opening and closing of curtain. He should fade the picture or effect on and off gradually, to convey an agreeable and smooth effect to the audience.

(14) He should be stationed constantly at the projector while it is in operation, and should be promptly responsive to signals for adjustment of volume.

(15) Where the control of the curtain is not directly handled from the projection room, a pre-arranged system of warning and closing signals should be used. Such signals usually consist of a two-buzz warning to the stage which is acknowledged on a return buzzer. A one-buzz signal is given at the moment of opening or closing of curtains or changing screen masking for various-sized pictures.

(16) Film should be examined after each run and checked for loose splices and scratches, and if oil has accumulated on the film, it should be wiped off and the projectors checked immediately to eliminate further scratching. Projectors also should be wiped dry of oil after each reel and checked for accumulations of emulsion from the film.

(17) Where more than one projectionist is on duty and when a projector has been threaded, the arc trimmed and fully prepared for the showing of each succeeding reel, the projectionist completing this work should step to the running projector and relieve the other projectionist, to allow him to check each detail of threading and trimming, noting that the proper reel has been placed in the projector. This routine of checking should be firmly established in the projection room as it has been the means of discovering faulty threading and incorrect reels in time to make corrections and avoid interruptions or film damage without making such errors evident to the audience.

(18) A minimum supply of spare parts should be determined upon. An accurate record of necessary spare parts and supplies should be kept by projectionists, and when items are used which reduce the amount below the minimum figure, such items should be reported in the "Supplies Needed" column of the projectionists' daily report.

(19) When ordering parts, the correct technical designation and catalogue number should be given wherever possible in order to avoid error in delivery. Catalogues of main items of equipment should be filed in the projection room for reference. Parts subject to breakage, such as gears, vacuum tubes, and connectors, should be distinguished from parts which are subject to gradual wear, and additional precautions should be taken to provide against emergencies arising through such breakage.

(20) To provide against accidental breakage of spare vacuum tubes, they should be stored in their individual boxes. Tubes, as well as other spare parts, should be further protected by being placed in a large metal cabinet containing shelves and equipped with a lock and key. This manner of storing will facilitate a rapid inventory checking of spare parts.

(21) Proper attention should be given by the projectionists to the matter of maintaining the proper level of electrolyte in batteries. The avoidance of over-charging or over-discharging will result in a full useful life of the storage batteries and, conversely, a lack of such attention will result in a very greatly shortened life and subsequent waste and expense for replacement.

(22) Where a generator is used in place of batteries it will be necessary to inspect the commutator each day and wipe it off with cheesecloth moistened slightly with vaseline. If this practice is regularly followed, the commutator should remain in condition for perfect sound reproduction.

(23) Exhibitors should acknowledge the good work of the projectionists in maintaining the equipment in the best condition and should be willing to institute new ideas and install new appliances which contribute to better performance or increased efficiency.

In conclusion, it is the belief of the committee that every owner, manager, and projectionist should take cognizance of the fact that the projectionist is in a position to contribute measureably to the advancement of the industry. Every projectionist should manifest a desire to conduct his work so that optimum screen results are efficiently secured.

Systematizing the routine work in the projection room is highly important, for it is only by the orderly arrangement of the many complex details that:

(1) thorough inspection, servicing, and checking of equipment can be made;

(2) equitable working arrangements, discipline, and harmonious coöperation between projectionists can be had;

(3) efficient results from projection and sound apparatus obtained;

(4) smoothly conducted performances secured.

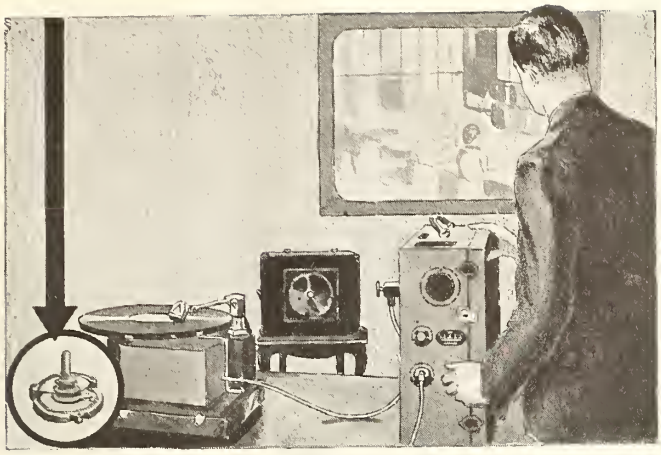
The foregoing is the report of the Sub-Committee on Monitoring and Control of Sound in Theatres, Society of Motion Picture Engineers, at the 1931 Hollywood meeting.

▲

BOOK REVIEW

PROJECTING SOUND PICTURES. By Aaron Nadell, 265 pp., Illus., Cloth. McGraw-Hill Book Company. New York. Price, $2.50.

The author is an engineer in the service of the Publix Theatres Corporation and was formerly employed by Electrical Research Products, Inc. With this practical background Mr. Nadell is qualified to write authoritatively on the subject of sound-picture projection. The book is well written and covers the design and operation of practically all modern theatre projection systems.



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Clarostat Volume Controls are absolutely quiet, long lived units, with special alloy contactor and windings to avoid thermal e.m.f. Made in simple potentiometer or dual and triple units for constant impedance work to meet exacting needs of sound industry. Insulated or grounded shaft and bushing, as desired.

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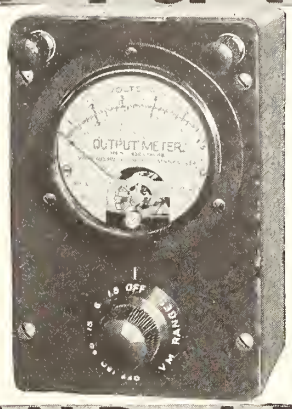

SOUND LEVEL

● With Weston Model 571 OUTPUT METER, correct sound volume in the auditorium may be determined from the projection booth.

● Model 571 measures the voltage output of sound apparatus—at speakers or any other convenient point. Notation may be made of the voltage outputs that produce the correct sound level for different capacity audiences. After this, the sound level may be regulated reliably and definitely from the booth by checking voltage output.

● Variations of voltage output—a possible breakdown—are immediately indicated with Model 571. This warning enables a change-over to the reserve circuit without annoyance to the audience.

● Besides, Model 571 OUTPUT METER is used for checking the relative volume of speakers, for determining the relative gain of tubes, and for determining fader settings.

● Developed to solve a practical problem that confronts every projectionist, Weston's 571 OUTPUT METER helps satisfy critical audiences. Its moderate price brings it within reach of every one interested in quality sound reproduction.

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Sound projection practice

Part II

(Continued from September issue of PROJECTION ENGINEERING)

ITEMS FOR FURTHER INVESTIGATION

Preferred Sound Track Size and Location

The considerations which dictate the preferred sound track size and location are twofold—first, engineering, and, second, economic. For the present the second of these dominates. Engineering considerations tend to favor an increase in sound track width over the present track, although such an increase cannot be carried on indefinitely without encountering further engineering difficulties.

A number of locations for the sound track differing from the present have been proposed. The majority of these offer little to be gained from an engineering standpoint. Their effect is mainly to permit a change in the present picture size, and the principal difficulty standing in the way is an economic one. Until it has been possible to make a further engineering study of this problem, it would appear to be undesirable to disturb the producers' and theatre owners' efforts to stabilize their economic positions by the introduction of equipment necessary to effect a relatively slight engineering or artistic improvement.

Sound from Separate Film

At the time when sound recording and reproducing was just getting a start, the need for double film was felt rather strongly. Some difficulty was experienced in the proper processing of both sound and picture on the same film, and, in addition, the theatre reproduction apparatus was less effective than it is today. At that time the industry was often able to obtain better than normal results by using the double film.

At present the situation is quite different. Theatre reproduction apparatus has been greatly improved, and, moreover, a large part of the available theatres have been provided with sound apparatus at considerable cost. To supersede this apparatus or to modify it in any way would represent a substantial increase in cost to the theatre and would present an economic problem which should not even be proposed unless substantial advantages are to be derived from the change.

Separate sound film installations would permit:

(1) control of sound film independent of the picture;

(2) separate handling of the release print in processing;

(3) wider sound track;

(4) higher running speed for sound track.

There are no data existing to show that these improvements warrant an expensive change. In the first place, it is no longer considered a serious handicap to the sound record that in variable density records a negative development must be accommodated to the processing of the composite print. By proper choice of conditions, satisfactory results can be obtained differing only in volume from what might be obtained with the separate sound film. Noise reduction technic applied to the composite sound record is adequate for practical theatre requirements.

Secondly, studio and laboratory technic has found practical solutions of most of the problems of development of picture and sound records on the same film, in positive form. This did not always seem feasible, but present results indicate no particular handicap. As a matter of fact, the positive control enforced by sound requirements has produced a general improvement in average picture print quality in many cases.

Somewhat the same reasoning applies to the wide sound track. With the track twice as wide as at present, an improvement of the order of three db. in signal-to-noise ratio should be obtained, with no change in quality. This improvement is scarcely sufficient to justify a large change in theatre apparatus, in the light of noise reduction studies which are at present under way.

The case of high running speed for the sound track has advantages since the greater the speed of the track the greater the ease of recording high frequencies. There should certainly be no difficulty, however, in recording frequencies up to 6000 or 7000 cycles on existing film stock running at the present standard speed. The present recording and reproducing equipment, at least with modifications and improvements which will be made as the art progresses, should be capable of recording and reproducing this frequency range.

H. B. SANTEE
Sound Committee, S. M. P. E.

It would, therefore, seem wise to exert efforts to obtain good, clear reproduction with present facilities rather than to introduce additional means for extended range at this time. Ultimately the state of the art may warrant the recording and reproduction of very high frequencies in the audible range but it is not believed that the time is opportune to consider costly changes toward this until full advantage is taken of present equipment.

An important economic phase of the handling of film is the mechanism of release through the exchanges. Handling and shipping problems are such that the extra cost and complication of handling a separate medium for sound is almost prohibitive. Moreover, the problem of maintaining synchronism must be admitted. No numbering system, however complete, can be as satisfactory in this respect as to have the picture and sound records unalterably tied together on the same film. Even at present, the producers annually furnish thousands of feet of short replacements to take care of inadvertent or deliberate changes of a print in the exchange or theatre to accommodate a particular situation. It has never been possible thus far, to prevent such changes being made. Obviously, it would be very much harder to handle this phase of the problem on a double medium basis.

In the light of this brief analysis, it is the Committee's definite recommendation that the Society should take a stand in favor of improvements known to be possible in the present standard composite picture and sound print.

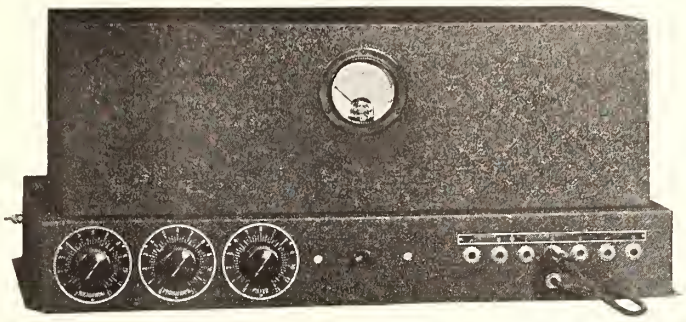
(*Concluded on page* 24)

Electro-Acoustic

EAP 12

Complete

Public Address Amplifier



A general purpose amplifier, ruggedly constructed, providing unexcelled quality of reproduction, and with sufficient power to deliver voice and music to thousands of people.

Four stages of amplification . . . three of resistance coupling with the output stage comprised of two type 250 tubes in push-pull. A variable output impedance permits proper matching to any load connected across the amplifier.

Excellent control of microphone or input from radio or phonograph through separate attenuators make possible superimposing of voice on music or vice versa. Many additional refinements, such as tone control and a double-scale meter to check the plate current in individual tubes as well as microphone current are also incorporated.

No preliminary stages of amplification or input transformers are required. To put the system into operation merely plug in your microphone and loud speaker.

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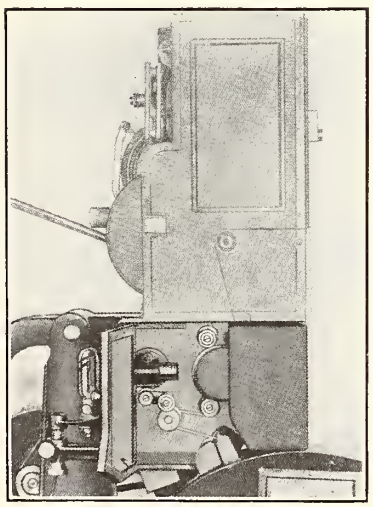

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Compact and sturdy in construction, simple to operate, perfect in efficiency. Smooth, quiet, positive drive assures even tone quality without distortion.

Sound heads for Simplex or Powers projectors are furnished complete and include optical systems, photo-cells, exciter lamps, adjustable motor mounting brackets, endless woven belts, grooved motor pulleys and all necessary attachments for projector.

EASY TO INSTALL

$275 per pair complete

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Volume Control in Recording

In the recording of sound for audible pictures, the volume range of the sound record is defined on the upper side by the overload point for the sound track and the cutover point for the disc, and on the lower side by the masking effect of the inherent noises in the sound record, known as ground noise or surface noise. This volume range was originally in the neighborhood of 30 db. and there was little choice between film and disc. As pointed out elsewhere in this report, the adoption of noiseless recording systems has increased the volume range on the film record by approximately 10 db.

In order to obtain a satisfactory ratio between the sound and noise level it was the custom in the past to raise the level of the weaker passages and lower the level of the louder passages at the time the record was made and to furnish the theatres with cue sheets directing the projectionists to lower or raise the sound level at these points by amounts specified in the cue sheet. In practice, this has not proved entirely successful, as the projectionist's attention has been so largely occupied by other matters that he has been unable to properly follow the instructions given in the cue sheet. It has been found practicable to record the sound on the film at the levels at which it is intended to be reproduced in the theatre. The cue sheet is, therefore, being abandoned. Consideration is being given to marking on the beginning of each reel in appropriate fashion the relative levels at which the reels should be reproduced.

The Committee will give further consideration to this important problem but suggests at this time that the trend be continued toward recording the sound at the proper levels.

During the past year, radical changes have taken place in film developing. Almost universally, the use of machines for release prints has become standard practice. The developing of picture and sound negatives by machine has become almost general, as the results of machine development have proved to be superior in obtaining uniformity and freedom from mechanical injury. A matter that requires further study is the composition and maintenance of the chemical bath.

Although information is available to permit the proper development of sound film, and devices for controlling and checking the methods are at hand, the full use of such facilities is not yet being made. A uniform and consistently good product can only be obtained by constantly employing such instruments as a means of checking the results.—H. B. Santee, *Chairman.*

▲ ▲ ▲

More about the Selenophone

SINCE the commercial adoption of film recording for sound picture work there have been many attempts at utilizing the device in place of phonograph discs for ordinary sound reproduction. It now appears that these attempts have taken practical form. The Austrian Selenophone Company, well known for their full-size sound projection system which has attained a degree of popularity in Europe, is now in process of manufacture of a home reproducing equipment which embodies sound-on-film recording.

In the April, 1931, issue of PROJECTION ENGINEERING appeared a special article on the subject of "Film for Home Recording," by A. L. Walker, which presented information in regard to the development of the product of the Austrian Selenophone Company. With further reference to this subject Mr. Walker writes:

"A similar process to the Selenophone is being developed in England by a small company, but so far nothing has transpired. I may mention that I have heard the Selenophone and examined the apparatus, but was not able to scrutinize details as I should have liked.

"However, I believe the comparative results of reflected light or sound reproduction are as high as 70 per cent when compared with the standard methods using transparent film. Naturally, a special type of paper is employed which, besides being tougher, has a very fine grain surface. I would emphasize the fact that the main idea behind the development of the Selenophone Company is that photographic records are not employed, but instead printed tracks are supplied to the customer. I believe the method of printing is the subject of several patents.

"There is usually less surface noise interference accompanying the use of reflected light than with transmitted. This is somewhat natural since scratches do not always affect the reflecting properties of a surface, whereas they are readily apparent by transmitted light.

"The variable area method is employed exclusively in the Selenophone and four such tracks are printed side by side in reverse directions. I am not sure, but I believe that the actual method of reversal of sound tracks is patented on the Continent, and, furthermore, a similar patent application has been lodged in England by E. Mills, whose agent is C. B. Gordon Sale, 16 Kelvin Avenue, Palmers Green, London, N.

"I have no actual data available, but it is evident that the efficiency of the process will be somewhat lower than in the case of transmitted light. However, to a large extent, this is compensated for by the adoption of the selenium cell in place of the ordinary photoelectric type. The amplifier used in this connection is of special construction having a rising response curve towards the higher frequencies, thus making up for the loss through the so-called inertia of selenium.

"I understand the Selenophone is being marketed in Austria. It is possible that a sample reel of paper sound track might be obtained by application to the Selenophone Company of Vienna, Austria.

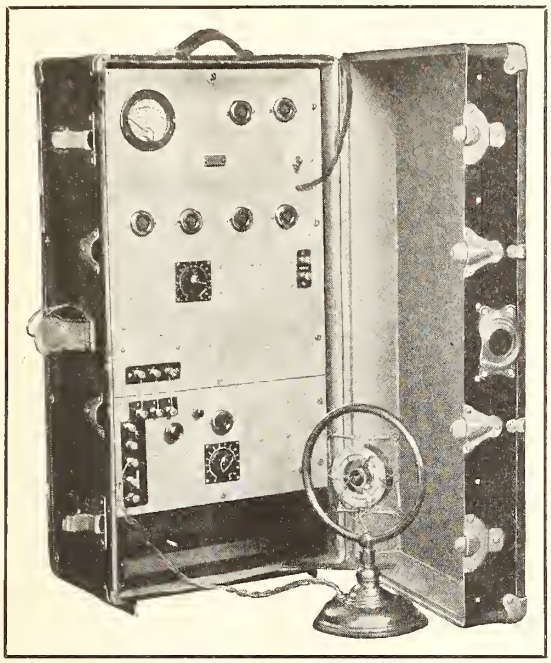
"The costs are absurdly low when compared with either the ordinary film method or the disc method. In fact, the Selenophone Company intend to compete with the ordinary electric phonograph employing standard discs.

"It is possible that within three years the Selenophone or its equivalent will be a rival of the discs of the phonograph companies, which undoubtedly have passed their peak and are incapable of further development due to the fact that, although the upper range of recording may be as high as 15,000 cycles, it is impossible to reproduce this owing to the fact that the finest practicable needle point has a diameter ranging between .003 and .006."

MAGNETIC PICKUPS

In the November issue of PROJECTION ENGINEERING *will appear an intensely interesting article on the development of magnetic pick-ups, prepared by E. W. Kellogg, of the RCA-Victor Company. Mr. Kellogg is the pioneer inventor of these devices.*

One Glance Will Convince Any Engineer of the Superior Construction of a



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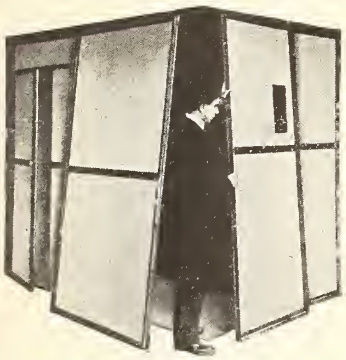

Both Portable and Permanent Type Projection and Transmitting Booths

STANDARD SIZES

4′	x 6′-3″	x 7′-1½″ high
6′-3″	x 8′	x 7′-1½″ high
8′-3″	x 9′	x 7′-1½″ high
9′-3″	x 12′	x 7′-1½″ high
9′-3″	x 14′	x 7′-1½″ high

THESE booths are made of ¼″ thick transite with angle iron 1¼″ x 1¼″ x 3/16″. The panels are interchangeable and bolted together with stove bolts. The seams are filled with transite cement. The floor sheets are ⅜″ thick asbestos.

The Underwriters throughout the country have approved these booths, as well as the fire and building departments of many cities.

Special booths built to conform with the Rules and Regulations of the Steamship Inspection Service on United States Shipping Lines.

Soundproof booths on rollers for microphone announcements from back-stage our latest specialty.

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New Developments and News of the Industry

RCA PHOTOPHONE

For the third time within the past few months, RCA Photophone portable sound reproducing equipment has been installed in the American Embassy, London, Eng., at the request of Ambassador Dawes, who entertained a party with a program of sound motion pictures. As upon the two previous occasions, Paramount cooperated with RCA Photophone in the presentation of the program.

▲

NEW VISITRON PHOTOELECTRIC CELL

A new size of Visitron photoelectric cell is announced by G-M Laboratories, Inc., Chicago, to meet the demand for a Visitron cell of medium size with a globular bulb. This new cell measures 2 13/16

inches from the bottom of the bakelite base to the top of the bulb, the bulb itself being 1 15/16 inches in diameter. Except in the matter of size, the Visitron 73-A is the same as other Visitrons having the same high sensitivity and long life for which Visitrons are noted.

▲

THE PAM-O-GRAPH

The Samson Pam-O-Graph will be found particularly useful in broadcasting studios for recording auditions or parts of radio programs. Schools and colleges can use it effectively in recording the lectures of prominent educators and members of the faculty for future reproduction. In the teaching of languages, dramatics, and elocution it is very helpful in correcting faulty pronunciation and enunciation. The large corporation can use it for sales promotion and advertising purposes, at conventions, in demonstration booths, etc. Police officials will now be able to record accurately and comprehensively the confessions and statements of criminals and witnesses.

The Pam-O-Graph comes complete, with tubes, microphone, microphone stand, 15 feet of microphone cable, recording needle, and a package of special bamboo playback needles. It is designed for operation from the ordinary 110-volt, 60-cycle, a-c. lamp socket.

It is manufactured by the Samson Electric Co., Canton, Mass.

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VACUUM TUBES FOR INDUSTRIAL PURPOSES

The Vas Corporation, 125 No. 3rd St., Newark, N. J., was incorporated for the purpose of conducting development work on industrial tubes and to produce on a commercial scale types for which there is a demand at present.

So far the efforts of the company have been devoted largely to several types of hot cathode vapor tubes. Rectifiers up to 75 amperes and up to 50,000 volts are being produced or are in preparation. A grid controlled rectifier which can be operated on d-c. similar to a power amplifier tube for high plate currents has been produced. A grid modulated hot cathode television lamp is in preparation.

▲

SELENIUM CELL

The Pacific Research Laboratories, 1907 Fourth Ave., Los Angeles, are marketing Type Z-A-C X-cell, a highly developed selenium light sensitive device for a-c. operation of sound equipment without the use of filters.

▲

KNOWLES BRINGS OUT NEW POWERS REAR SHUTTER

A new rear shutter for Powers projectors that is said to afford nearly 78 per cent cooling at the aperture, an almost complete absence of film buckling and a light increase of 20 to 35 per cent at the screen, has been developed and is being marketed by the Knowles Rear Shutter Co. of Los Angeles, Cal.

This device, the company claims, modernizes the Powers projector to where it is no longer necessary to discard the Powers now in use for a heavier and more expensive make of projector because of the excessive heat generated by the high intensity arc. A smooth and novel framing device replaces the old jerky form of framing bar that invariably overshot the mark. A quick means of setting the shutter while running is also had with a new type of collapsible glare shield.

The device is built as an integral part of the projector head mechanism and will last as long as the projector itself, besides sharpening the focus to a truly remarkable degree, the company states.

▲

IN FAIRNESS TO THE SCREEN

In line with the great improvements which the past few seasons have found in projection screens is the increasing appreciation by projectionists of the fact that in order to give the new and better screens an opportunity to do their best, modern projector lamps are required.

This is plainly indicated by the increasing popularity of the equipment built by Hall & Connolly, Inc., who report recent sales of its FR-10 projection lamps to the RKO Plaza of Schenectady, N. Y., the Palace Theatre, of Milwaukee and to the export department of the National Theatre Supply Company, for shipment to Manila, P. I.

Other recent Hall & Connolly shipments include nine EF-4 Spots. Six of these were to the Earl Carroll Theatre, New York, two to the RKO Palace, Columbus, Ohio and one to another RKO house, the Plaza, of Schenectady, N. Y.

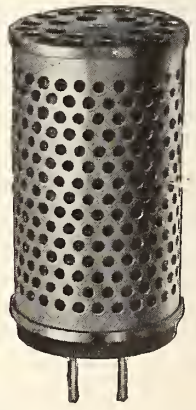
▲

NEWEST LINE RESISTORS FOR D-C. SETS ELIMINATE HEATING TROUBLES

A brand new plug-in type line resistor has been developed by the Clarostat Mfg. Company, of Brooklyn, N. Y., especially for use in d-c. radio receivers. Set manufacturers who have changed over their 110-volt d-c. sets to use the new 6-volt, 0.3 ampere tubes, will find this resistor particularly applicable to their needs.

The new line resistor follows the same general construction which has proved so efficient in the Clarostat line ballast. It is wound on a sturdy mica frame, and is protected by its perforated metal housing which acts as a ventilating stack, thus rapidly dissipating heat. The unique method of construction tends to keep the line resistor from heating up. This prevents possible injury to nearby components and also precludes disturbing capacity or inductance changes due to overheating. Hence, maximum efficiency of operation is definitely assured.

The Clarostat line resistor may be plugged into a regular two hole tube-type socket, or it may be obtained with flat prongs, for use in any standard electrical outlet. Line resistors of various values are



available to supply the voltage drop required in reducing the standard line potential (110-115 volts, etc.) to the value needed by the tubes, which are all connected in series. The cost of the new Clarostat line resistor, compares favorably with the ordinary enamelled resistor and cover, which it now renders obsolete.

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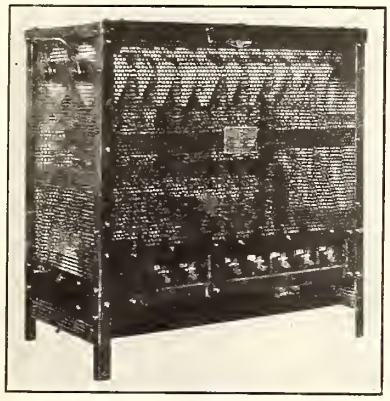

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Rochester, New York

TEN INTERESTING AND TIMELY TECHNICAL PAPERS BY OUTSTANDING ENGINEERS ARE SURE TO MAKE RADIO HISTORY

Projection Engineering will be represented by members of its Editorial staff.

LIGHT RELAY AND LIGHT SOURCE UNITS

Complete, ready-to-use light relay and light source units of extreme simplicity, ruggedness and reliability, are announced by the Radiovisor Division of the Burgess Battery Co., 202 E. 44th St., New York. The units are designed around the novel Burgess Radiovisor Bridge or light-sensitive cell.

The Burgess light relay units are available in both a-c. and d-c. models for use on usual power supplies. The units are in the form of an aluminum housing with window, containing a circular platform on which the bridge, tubes and other components are mounted. The a-c. unit comprises bridge, two 427 type tubes serving as amplifier and rectifier respectively, power transformer, filter condenser, resistors, by-pass condensers and power relay. The d-c. unit comprises bridge, one 427 type tube serving as amplifier, voltage reducing and other resistors, by-pass condenser and power relay. The unit housing is held by a wall bracket ring, permitting necessary adjustments to line up the window with the actuating light source. When provided with the Burgess vacuum contact, the light relay can control a circuit handling up to 1,320 watts.

▲

PAM PUBLIC ADDRESS SYSTEM

The Midget, the new Samson portable PAM address system consists of a PAM 71 speaker amplifier, MIK 71 microphone amplifier, and a dynamic loudspeaker compactly and permanently fitted into a small carrying case. All of the accessories—microphone, cords, plugs, etc.,—are stored in separate compartments of the case made especially for the purpose.

For gatherings up to 500 people the Midget PAM address system offers exceptionally high-quality equipment at an extremely low price. It has a wide variety of uses.

The Midget is manufactured by the Samson Electric Co., Canton, Mass.

▲

VISITRON SALES SHOW MARKED INCREASE

Sales of Visitron photoelectric cells made through National Theatre Supply branches, have recently increased more than fifty per cent, according to G-M Laboratories, Inc., of Chicago. The increase is attributed to the known fact that many exhibitors are now getting their projection equipment in proper order for Fall business, and to a general realization of the importance of the photoelectric cell as a necessity to better sound performance. Although properly constructed cells have a very long life expectancy under average conditions of operation, they should nevertheless be inspected and tested periodically for output and operating efficiency, inasmuch as they are vital to correct talking picture presentation.

The importance of making a thorough examination of sound equipment in preparation for the coming season cannot be over-emphasized, and of all parts of the sound equipment there is no more vital part than the photoelectric cell.

▲

NEW PHOTOELECTRIC CELL

The development of the Weston photronic cell, with its amazing performance characteristics and its utter simplicity of design marks a sensational advance and fulfills the need for an ideal type of photoelectric cell. Notwithstanding the superiority of this Photronic Cell, it is exceptionally low in cost as is also its auxiliary apparatus. Its discovery now places photo cell equipment well within reach of every amateur experimenter.

Electronic in its character, the Weston photronic cell employs a highly light sensitive disc which transforms light energy directly into electrical energy without the use of any auxiliary voltage whatsoever. Its response to light variations is instantaneous and sufficient current is developed to directly operate relays without the use of auxiliary apparatus or any battery. It delivers about one microampere per foot-candle of light intensity. When exposed to direct sunlight the output is approximately 5 milliamperes. The cell resistance varies from about 1500 ohms for 10 foot-candles light intensity to about 300 ohms for 240 foot-candles intensity.

As far as is known, the life of the cell is practically unlimited and a continuous current flow does not harm it in any way. Since it does not contain any liquid nor require vacuum or gas, there is nothing to get out of order as it is not subject to physical or chemical change and it has a constant output. It can be exposed to direct sunlight without deterioration, has no dark current since its energy is derived directly and only from light; no drifting, hence no circuit adjustments are necessary; no fatigue and it is non-microphonic.

The photronic cell is enclosed in a handsome moulded black Bakelite case fitted at the bottom with two connection prongs which fit into the standard UX radio tube socket. It is rugged in construction and is so simple in design that there is nothing to get out of order. The case is 2¼ inches in diameter and 1 inch in thickness.

▲

CLAROSTAT SPONSORS DUAL VOLUME CONTROLS OF IMPROVED DESIGN

In line with the trend towards increased compactness in the design of radio parts, Clarostat engineers announce an improved type of dual volume and constant impedance controls. These latest additions to the Clarostat line, include in their construction all the advantages which have popularized the older model Clarostat dual controls. The new models, however, contain special features which greatly increase their efficiency and utility.

A new coupling arrangement results in a very sturdy unit and eliminates all chance for lost motion between the ele-

ments. An electrostatic shield is provided between the two potentiometers. This is often of considerable value in preventing undesired coupling between the two circuits.

The new Clarostat dual controls are much smaller than previous models and project only 1¾ inches behind the mounting panel. These controls are available with any combination of resistance elements, with standard or reversed taper, either with or without the new built-in 110-volt switch recently announced by the Clarostat Company.

▲

DUNCO INTRODUCES LOW COST LIGHT SENSITIVE CELL UNIT

Much has been expected, and much has been accomplished by the light sensitive cell, but, until now, its full application has been rather restricted due to the high cost of these units—usually a hundred dollars and over.

Now, however, Struthers Dunn, Inc., 127 N. Juniper Street, Philadelphia, have announced the Dunco light sensitive cell unit which lists at $30, less tube.

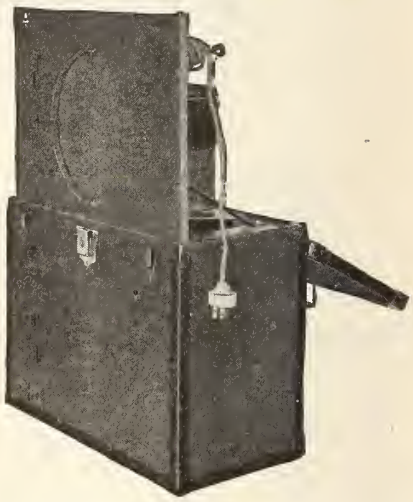
This unit is housed in a case 6 x 5 x 3″ overall, having an aluminum finish. It operates on standard voltage, 110 volts, 60 cycles, although special sets, both a-c. and d-c. can be built to order for voltages other than this. The Dunco uses a standard 112-A tube.

As is the case with any light sensitive cell unit, the new Dunco unit will operate at practically any distance, being limited only by the distance that light can be thrown. Either reflected or diffused light will operate the unit, which is adjusted at the factory for operation requiring a ten-watt lighted lamp being placed one foot away. This is without the use of any reflecting device. The unit, however, can be adjusted for more sensitive operation.

▲

INTERNATIONAL PROJECTOR MARKETING NEW PORTABLE

Acme 35 mm. portable projector and sound-film reproducer, designed primarily as a portable unit, but equipped with a complete professional optical system for use in moderately-sized auditoriums, and in small theatres where a picture of the maximum size of 12 x 16 feet is desired, is being marketed by International Pro-



jector Corp., 90 Gold St., New York City. Entire assembly weighs about 100 pounds.

This new equipment, simple in operation yet sturdy in construction, consists of a portable motion picture projector and sound reproducing equipment of fundamentally new design.

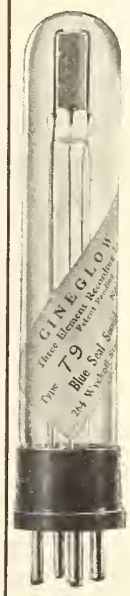
The condensing system consists of the Bausch and Lomb Cinephor PM-15 and PM-25, and projection lens mounts are so constructed that any type of lens may be used. This means that the full-size, No. 2 or Series II lenses may be readily accommodated in any focal length. The sound reproducing equipment is said to have received equal consideration in its construction. The exciter lamp socket is rugged and the optical system is sturdy and rigidly mounted. No tension shoes or springs, in the sound reproducing gate, are used at the sound take-off aperture. The film after leaving the sound gate feed sprocket is passed over a roller and tension is applied at this point.

The amplifier used with the Acme portable equipment is the product of RCA Photophone, Inc., and is completely operated. It is mounted in a carrying case and weighs approximately 40 pounds.

A system of changeover switches has also been developed for use in connection with two of these new Acme projectors so that a sound-on-film program may be projected with equal ease and with the same results as obtained in a modern theatre, the company declares.

Blue Seal offers Cineglow Sound Systems!

PERFECT SOUND-ON-FILM RECORDING AND THE THREE ELEMENT GLOW LAMP



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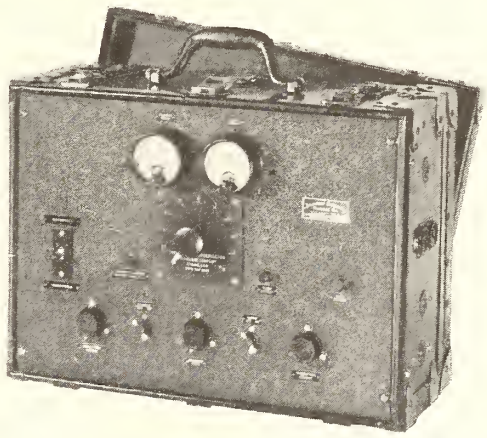
Type 2-A



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Type 2-A Amplifier including carrying case $235.00
With built-in Volume Indicator 265.00

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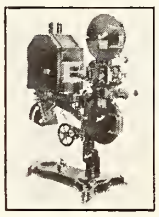

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See Group Plan Page 31

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, OF PROJECTION ENGINEERING.
Published monthly at New York, N. Y., for October 1, 1931.

State of New York }
County of New York } ss

Before me, a Notary Public in and for the State and county aforesaid, personally appeared B. S. Davis, who, having been duly sworn according to law, deposes and says that he is the Business Manager of PROJECTION ENGINEERING, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24th, 1912, embodied in section 411, Postal Laws and Regulations, to wit: 1. That the names and addresses of the publisher, editor, managnig editor, and business manager are: Publisher, Bryan Davis Publishing Co., Inc., 52 Vanderbilt Avenue, New York; Editor, Donald McNicol, Roselle Park, N. J.; Managing Editor, F. Walen, Union City, N. J.; Business Manager, B. S. Davis, Scarsdale, N. Y. 2. That the owners are: Bryan Davis Pub. Co., Inc.; B. S. Davis, Scarsdale, N. Y.; Roy T. Atwood, Albany, N. Y.; G. R. Bacon, Dougleston, N. Y.; J. C. Munn, Union City, Pa.; J. A. Walker, Richmond Hill, N. Y.; A. B. Goodenough, New Rochelle, N. Y. 3. That the known bondholders, mortgagees, and other security holders owning or holding 1% or more of the total amount of bonds, mortgages, or other securities are: None. 4. That the two paragraphs next above giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where a stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also, that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

(Signed) B. S. DAVIS, Business Manager.

Sworn to and subscribed before me this 19th day of September, 1931.

(Seal) M. S. OELSNER, Notary Public.

N. Y. County.
New York Co., Clerk's No. 27.
New York Co., Register's No. 3-0-10.
Commission expires March 30, 1933.

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sound motion picture equipment

—how to operate it
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This new book makes easy the successful operation and repair of all makes of sound projection apparatus, by explaining simply and clearly the fundamentals of sound reproduction and projection upon which all types of equipment are based.

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Whether you are a sound projectionist by profession or only occasionally work on sound equipment, you will find this an invaluable handbook, presenting the fundamentals that will enable you to understand the problems arising in the operation and repair of all makes of sound equipment.

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Beside explaining the theory of sound reproduction on disc and film, the book takes up each unit of the sound equipment, explaining the underlying theory and principles, showing by description and illustration how these are applied in various types of apparatus.

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Because of its value in forming a clear understanding of the operation of tubes and photo-electric cells, the electron theory of the nature of currents is explained, in a surprisingly simple way. The book is thorough, authoritative, practical. It minimizes constructional details of various makes of equipment in favor of the basic facts that will enable you to understand all makes.

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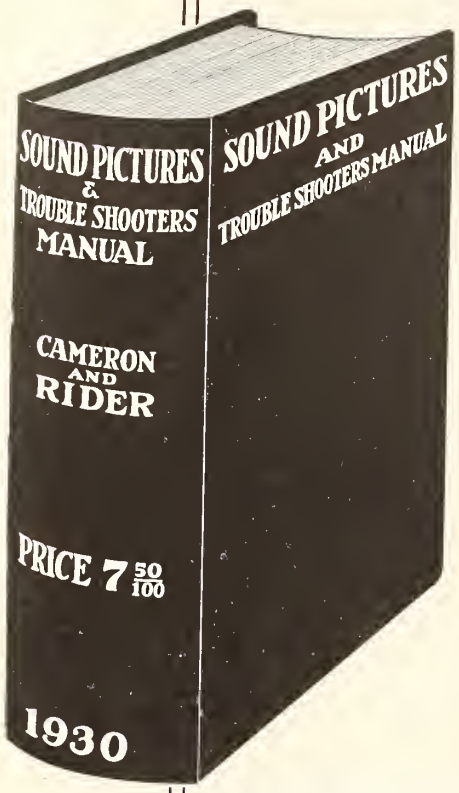

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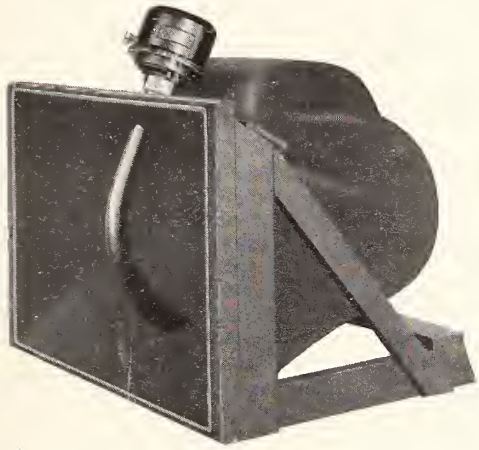

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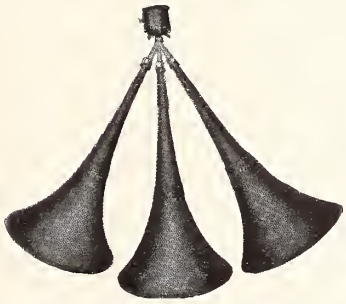

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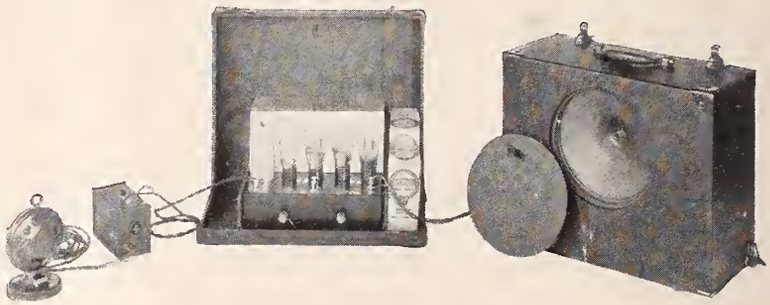

The 686 Portable Address Unit contains a five-tube push-pull Pentode Amplifier having a gain of 90 DB and an undistorted output of 7 to 8 watts. It is entirely free from hum. Its fidelity curve shows a variance of only 2 DB, plus or minus, from 40 to 8,500 cycles.

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Projection Engineering

SOUND —·— VISUAL

IN THIS ISSUE

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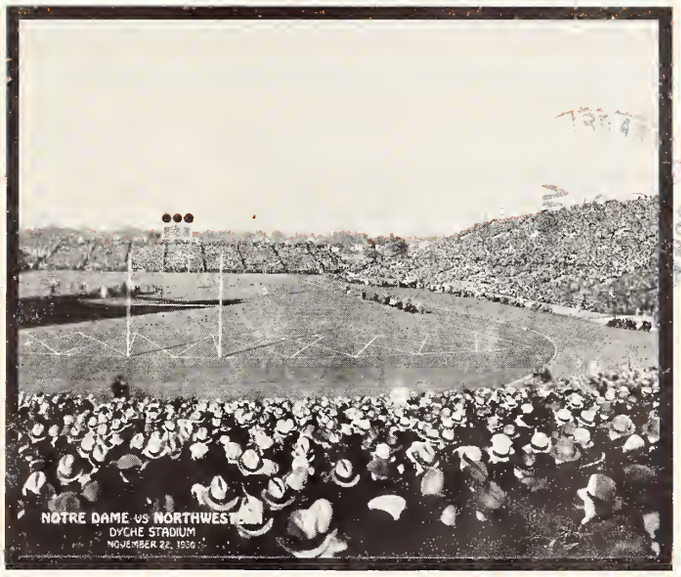
By Gordon S. Mitchell

MAGNETIC PICKUPS AND LOUDSPEAKERS
By E. W. Kellogg

EDUCATIONAL SOUND MOTION PICTURES
By Dr. Alfred N. Goldsmith

THE CAMERA AND THE EYE
By Dr. Park Lewis



Photo, courtesy Operadio Mfg. Co.

Sound amplifying equipment mounted above score board.

Third Year Of Service

Journal of the Sound and Light Projection Industries

NOVEMBER, 1931

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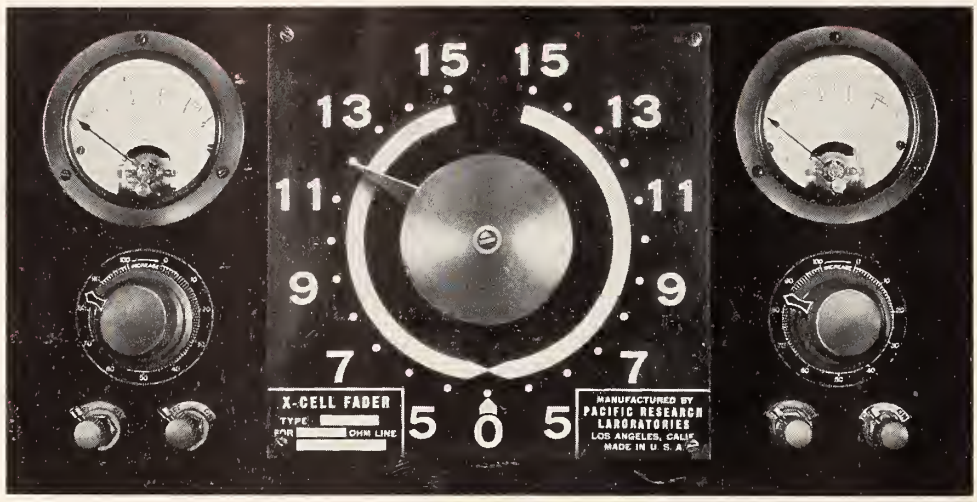
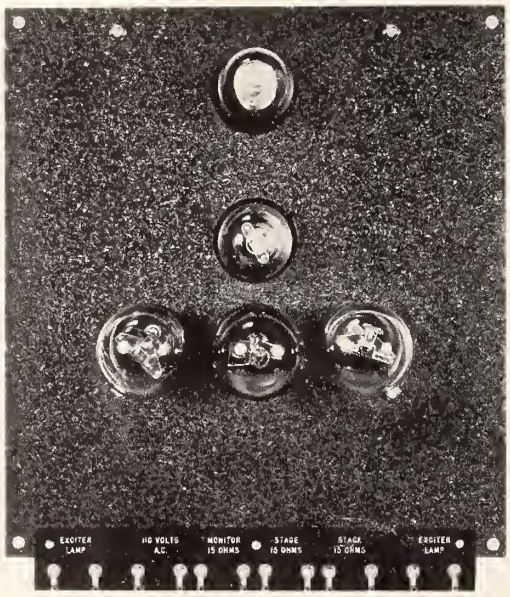
FOR COMPLETE A.C. OPERATION OF SOUND-ON-FILM APPARATUS



TOP OF P-R-L 7-A CABINET

The upper illustration shows the Control Panel of the P-R-L 7-A Sound System built in the top of the cabinet which houses the entire apparatus. It consists of a D.C. ammeter, rheostat and switch for each exciter lamp and a calibrated wire-wound resistor fader-volume control. Only the finest of materials are used in the control assembly, thus assuring a positive and smooth change-over which is so essential to the proper presentation of talking motion pictures.



P-R-L 7-A AMPLIFIER PANEL

The 7-A Amplifier Panel shown at the left consists of a steel panel 12" x 15" on which is mounted the entire amplifying and power supply apparatus. It consists of a three-stage hi-gain amplifier with an undistorted output of six watts which will furnish coverage up to 750 seats with two dynamic speakers and up to 1,500 seats with one air-column horn. In case of breakdown, this amplifier panel, which is held in the cabinet on four studs, may be removed and a new one substituted in ten minutes without disturbing the installation as a whole.

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Vol. III — NOVEMBER 1931 — Number 11

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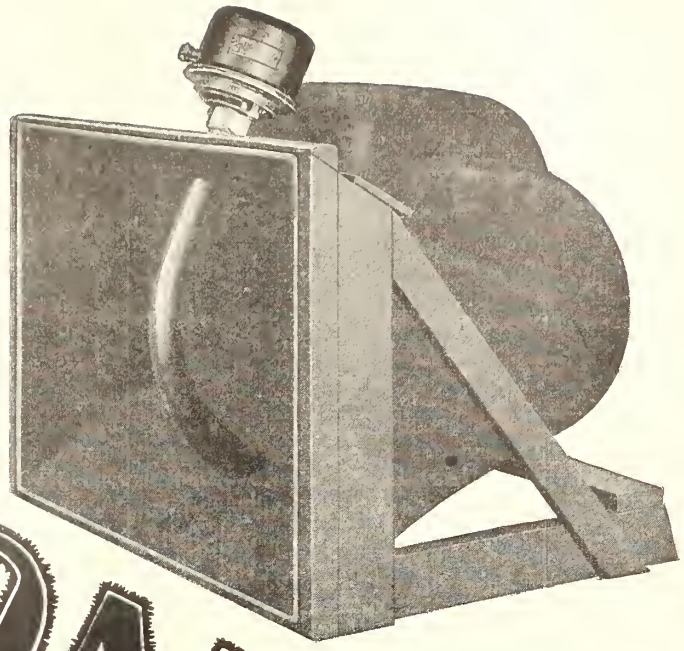
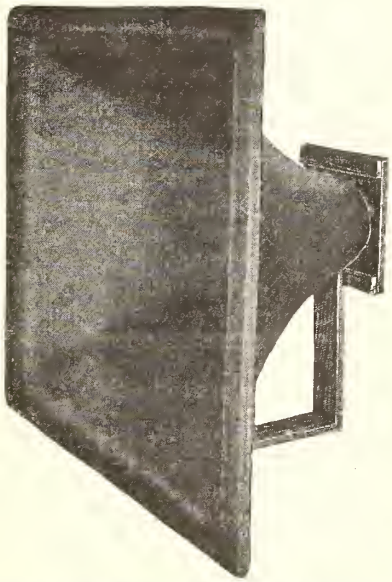
RACON





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Editorial

NOVEMBER, 1931

TUBE REQUIREMENTS OF THEATRES

OF the 11,500 wired theatres in the United States, upward of 3,000 use R. C. A.-Photophone sound equipment, and approximately 5,200 use Western Electric (ERPI) equipment.

The tube requirements of theatres vary from $75 to $174 per theatre. A medium sized theatre equipped with W. E. sound represents for tubes about $106.

Assuming that on the average tubes are replaced three times per year this would total for 8,200 theatres $2,607,600.

While the two major theatre sound equipment manufacturing companies have advantages of contact for tube sales, the effect of the recent announcement of the settlement of the vacuum tube suits of R. C. A., de Forest, Arcturus, and nineteen other tube manufacturers, should be the opening of a free-for-all market for tube replacements—for those tube companies licensed.

With approximately 10,000 theatres yet to be equipped with sound installations, there would appear to be an ultimate market in this country alone for tubes totaling in annual cost $6,360,000.

▲

THERMIONIC TUBE CONTROL OF THEATRE LIGHTING

A PAPER presented at the Swampscott meeting of the S.M.P.E., in October, by Burt S. Burke, gives interesting information about the new thermionic tube control system of theatre lighting.

The development of thermionic tubes has opened an entirely new field in this direction and has made possible the obtaining of preset dimming, proportional dimming and a small compact switchboard such as has been heretofore impossible.

The preset dimming feature allows an operation whereby a board may be set up for any desired number of effects in advance, so that these effects may be called for at the will of the operator by the manipulation of a single control.

▲

CAMERA AND PROJECTION APERTURES

WITH reference to camera and projector apertures in relation to sound-on-film pictures, Lester Cowan, executive secretary of the Academy of Motion Picture Arts and Sciences, is carrying on constructive educational work, which when it is understood by projectionists, will no doubt be properly appreciated.

In Hollywood there has been concern among studio technicians due to experience in some theatres where the heads and feet of some characters, important words in titles, and other essential elements of pictures, have been cut off in projection of sound-on-film showings.

In some instances projectionists have inserted in the film gate a solid sliding aperture which masked out from the top and bottom of the picture an amount sufficient to restore normal picture proportions. The smaller aperture reduced the height to three-fourths of the width which had been diminished by the addition of the sound track. The smaller rectangular picture when projected with a one half inch focal length lens filled the screen with a picture equal in area to the silent picture.

Except in a few cases cinematographers had not been warned of the reduced aperture practice. They did not anticipate it in their photography. The result was that parts of the picture were being cut out which cameramen assumed would reach the screen as usual. Studio technicians in general were at a loss to know what to do; they did not know the extent of the practice or the exact size of the reduced aperture. An immediate coördination of studio practices with existing theatre methods was imperative. To this end a nation-wide survey of theatre chain and production studio practices was launched by the Academy of Motion Picture Arts and Sciences with the assistance of the Technical Bureau of the Association of Motion Picture Producers.

The survey brings to light various methods employed to overcome the difficulty, out of which no doubt correction will come.

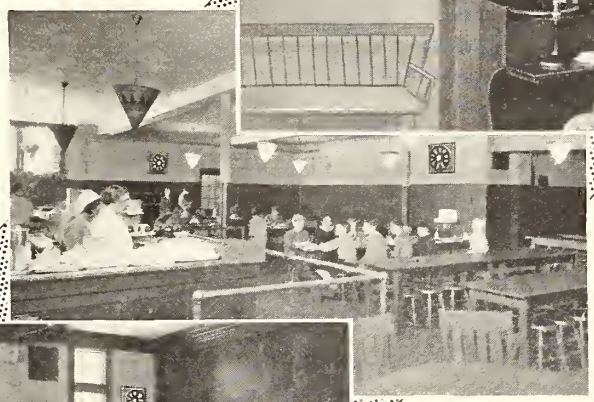
Donald McNicol

Editor

LOWEST COST PER ROOM

A New Low Priced Centralized Sound System is Available.... to all Schools

The Samson Electric Co., designers and manufacturers of school centralized sound systems of the rack and panel and table types in operation in hundreds of schools today, announces a new dual type known as the PMR JR. 25.



WITH THIS NEW system you can reproduce with great fidelity a radio program, phonograph records or announcements from a microphone with sufficient volume for classroom, auditorium, gymnasium or cafeteria.

At *all* times the Principal can make announcements to *all* rooms—even when the teacher has turned off the reproduction at the local control in the room.

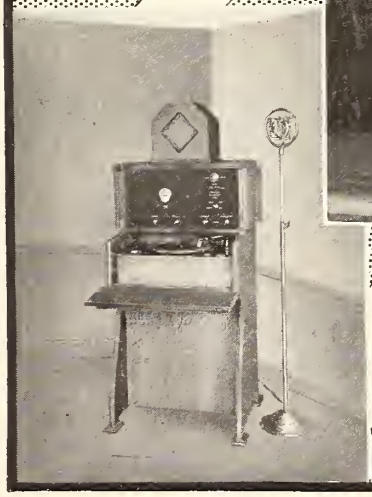
More time can be devoted to teaching by users of Samson Junior PMR systems as the local control eliminates the need of constant attention at switchboard.

The Junior PMR 25 for schools of 25 rooms or less and the Junior PMR 50 for those of fifty rooms or less consist of a radio set, power amplifier, microphone amplifier, electric phonograph turntable, pickup and control panel all enclosed in lockable oak cabinet, to harmonize with school furniture, complete with tubes, monitor loud speaker, microphone and stand. For larger schools we recommend our rack and panel equipment.

Because hundreds of Samson centralized sound systems are in use in schools and our electrical manufacturing experience covers 49 years we can guarantee you the maximum of service and dependability.

In order to secure best results, be sure in your choice of a school sound system that the integral parts and accessories are designed by one manufacturer as is the case with the Samson Junior PMR system.

An illustrated bulletin, PE No. 14, fully describing this new Samson system will gladly be sent upon request.



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Projection Engineering

NOVEMBER, 1931

Film or wax sound records?

By Gordon S. Mitchell*

Although film sound track appears to be gaining on the wax record method, there remains a difference of opinion, as regards the quality of reproduction.

In any gathering of sound technicians, the conversation will sooner or later turn to the advantages of film recording over disc, or vice versa. While there were certain very pronounced points of superiority of each system over the other during the early days of motion picture sound recording, these pronounced points have more or less disappeared and the advantages of one system are nearly outweighed by disadvantages of the same system or advantages of the other. Superiority of one system over the other should first of all be considered from a standpoint of sound quality, then from a standpoint of operation, then from a standpoint of cost. The present pronounced success of the talking motion picture is entirely due to the excellence of the quality of recorded sound as heard in the theatre—a statement which needs no qualification although it might bear explanation. While the present-day motion picture as such stands or falls on the strength of the story, the cast, the treatment, and other details of production, the present-day motion picture as a class—as an industry—owes its entire being to the advances which have been made in recording during the period intervening since the production of the first sound picture. Without the technical progress which has been made the audible motion picture would have attracted but little attention. Sound motion pictures as they were during the first months of the sound era would never have satisfied a critical public for long. Technical advances which were made almost daily served as life blood to the ailing industry and turned what might have been a colossal failure into what has since proved to be a success.

Quality

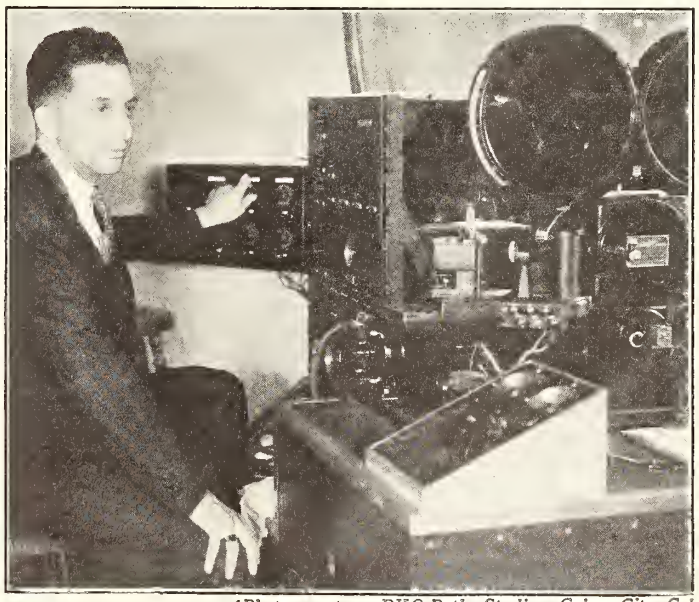
Inasmuch as the present-day motion picture owes its success to the improving quality of recorded sound, in a last analysis quality is the most important consideration upon which to base a study of the subject.

In the beginning, disc recording was the only practical method which had stood the trials of production, hence it was the method adopted by Warner Brothers for recording sound for their motion pictures. It has been recently stated by engineers connected with the Warner Brothers sound department that the best film recording made under production conditions equals in quality the average production disc recording. While both film and disc recordings can be made in the laboratory under ideal conditions by expert engineers, with developing and printing or processing also done under strictly laboratory conditions which are perfect so far as recording technique is concerned, these recordings should not be considered in the same classification as recordings which are made with the regular operating personnel under ordinary production routine. In a comparison of the two methods of sound recordings for quality regular production film or disc should be used and under as near theatre projection conditions as possible.

In order to study at first hand and obtain authentic information on both methods of recording, Warner Brothers have for some time been recording most of their sound on both film and wax. It has been stated by their sound engineers that in spite of the theoretical advantages which have been proven for the film method of recording, the disc method has so far given the best frequency response in actual production.

It shall be the writer's endeavor to point out some of the advantages as well as the disadvantages of each system strictly impartially, leaving the final conclusions to be drawn by the reader after consideration of the following facts.

In the first place, wax discs have been cut for over twenty-five years in



Film recorder, showing mixing panel and recording light housing, as used at RKO-Pathe Studios.

(Photo courtesy RKO-Pathe Studios, Culver City, Cal.)

*Electrical Engineer, Sound Department, Universal Pictures Corp.

the phonograph industry, hence cutting and processing procedure has had ample time to become standardized and perfected to a high degree. Experience in the electrical cutting of wax records had been accumulating for a short time before the advent of sound in motion pictures, so no appreciable difficulties were noted from that source. Of course, no such experience can be claimed for the film method of recording. All knowledge which has been gained has been gained in the laboratory and the studio directly from motion picture sound recording work.

From a purely theoretical standpoint, there should be a better frequency response in the film method of recording. An inertia-less light beam and an aperiodic photoelectric cell are capable of response to frequencies of a higher order than are the moving mass parts of the wax recorder. Laboratory tests have shown that this is true, but the theoretical advantage is lost in production due to the fact that the other portions of the system cannot perform in a comparably efficient manner.

Inertia

While it is claimed that the inertia of the wax record makes it less susceptible to irregularities of speed and consequently tends to iron out any small irregularities in the recording, the driven rotating parts of the film recorder fulfill in a measure the same function and supply the inertia lacking in the film itself.

It must be admitted that there has been considerable difficulty in those studios which record sound-on-film in obtaining a satisfactory laboratory treatment of the sound track. Tolerances in exposure, development and printing which have been set up as necessary for satisfactory sound reproduction have been extremely difficult and also expensive to meet in actual production. In addition the equipment necessary to develop and print sound track is more complicated and hence more expensive than its counterpart in the disc recording studios. In the processing of disc records there is no analagous difficulty experienced such as is experienced in establishing a happy medium which will allow satisfactory picture projection as well as good quality sound. The standards set up for the photographic control of the compound or "Movietone" print, (print with both sound and action on one film) have at best proven to be a compromise and although results as noted in the theatre have proven satisfactory from the public standpoint, efforts are constantly being expended in the studios to improve on this phase of the problem. It should be noted that laboratory technique is improving all of the time, and improved results have been the result of an increasing knowledge and application of sensitometric control.

Synchronism

From the standpoint of synchronism, the film method of recording has an advantage which is universally recognized. In case of a bad tear developing in the Movietone print, the damaged section may be removed and the film spliced, eliminating entirely the few frames which may have been damaged. At worst, with bad patching this elimination will result in a click in the reproducing horns and a jump in the picture (the magnitude of the jump of course depending upon the number of frames removed and the speed of the action at the particular point). Inasmuch as just as much sound track as picture has been removed there will be no appreciable loss of synchronism at that point. (This statement to be strictly correct must be qualified somewhat—there will be a period of time corresponding to the time required for the passage of nineteen frames through the projection machine during which the picture will be out of synchronism. This is due to the differential of nineteen frames which is standard in the sound-on-film type print, and will be of such short duration that none but a trained observer would notice it.) However, in case of a tear in a Vitaphone print, exactly as much blank leader must be inserted in the picture as has been removed in order to keep sound and action in synchronism. While this results in no extraneous noise in the reproducing horns, it does result in a usually much more noticeable flash in the picture. In addition there is always the danger that exactly as much film will not be inserted as was removed and there will be a consequent loss in synchronism which will be retained throughout the remainder of the reel.

Convenience of Recording

From the director's and cutter's standpoint there is an obvious advantage to the film method of recording. With the sound track recorded on film it is possible for the director or cutter to make his cuts wherever he so desires, patch the two films together and immediately run his sound and action in the projection room. He may then recut wherever he desires, re-run the changed film, and so on until the results suit in every particular. It is not necessary for him to wait for the reel to be re-recorded before he is able to determine absolutely the effects of the cuts as made. However, inasmuch as there is no appreciable loss in quality during re-recording, there is little or no choice between the two methods from a sound department standpoint.

This advantage possessed by the film method of recording has been recognized by the studios using the Vitaphone method, and for some time Warner Brothers Studios have made a practice of furnishing the cutter with recorded sound track which he uses in assembling his pictures, after which a final re-recording is made by the sound department from the wax duplicate of the film track.

The wax recording method, to offset the disadvantage in cutting procedure noted above, has one very pronounced advantage to the director inasmuch as it is possible for him to play a wax record back on the stage immediately, giving an opportunity for cast and director to hear the sound exactly as recorded and a chance to improve on any points if necessary. With sound recorded on film the director is faced with the necessity of placing sole reliance upon the monitor until such a time as he is enabled later to see and hear his rushes, which is usually about twenty-four hours after recording. If at that time he is dissatisfied for any reason with the sound as recorded, it is necessary for him to recall his cast and retake the scene.

Inasmuch as everything is re-recorded before release, it is possible to use a heavier cut on first recording than would be commercially satisfactory for release records. This eliminates the possibility in retakes due to cutover, consequently there is little or no delay due to sound in production.

Reproduction

In the matter of sound reproduction in the theatre, the wax equipment is considerably simpler to operate than is the film equipment. The only attention necessary is to periodically replace the needles, and in case of trouble install a new pickup mechanism. A spare pickup is kept on hand in each theatre, there being no adjustments which can be made to the pickup in case of trouble developing. In the film reproducer, as first consideration there are the mechanical guides which keep the film in alignment with the sound gate, the clearance being so small that if these guides are not in exact position reproduction suffers. The light must be adjusted as to position and current and the optical system must be kept in focus for satisfactory results. In addition there is the two stage amplifier which is fed by the photoelectric cell and which is necessarily of low level, hence subject to induced noise as well as vibrational disturbances. This amplifier helps to raise the ratio of tube and cell noise to desired sound, which

ratio is carried through the remainder of the system and tends to make the level of extraneous noise higher in a film reproducing system than a disc.

Cost

Looked at from the cost standpoint, it would seem that the film method has the advantage. As the release print leaves the laboratories for the exchanges, it consists of one reel containing both sound and action, unchanged in form from pre-sound days. There has been no increase in exchange costs to companies recording on film as a result of the addition of sound to the motion picture. However, companies using the disc method of recording are faced with the necessity for two separate exchange organizations, one for the picture and one for the sound record. This necessitates two shipments at a slightly increased shipping cost with just twice the danger of error being made in the exchange.

There is very little data available on the life of sound prints, although at present it appears that the combination print will last from 50 to 100 per cent of the time which the old silent print would last depending entirely upon the care exercised in handling. In the beginning, sound prints were run from fifty to sixty times in the first run houses, which resulted in an increase in cost for prints of from five to six times what it had been in the silent days, and which would more than offset the cost of replacement discs. Due to the fact that it is necessary to replace both sound and action when the print begins to go bad (and it is the sound quality which begins to suffer first due to dirt and oil on the print, damage to the track in passing through the projection machine, etc.), a reel is often kept in service long after it should have been, from a sound quality standpoint, replaced. Due to the relatively low cost of replacement discs, it is possible to obtain retirement of a disc when sound quality begins to suffer. This is a distinct advantage to the second and third run houses, and accounts for the fact that in many cases sound-on-disc is better in the small neighborhood house than is sound-on-film in the same theatre.

Modulation

Modulation of sound is sometimes caused (when sound is recorded on film) by a shrinking of the film which results in a slippage as it passes through the projection machine. There is no comparable trouble experienced with sound-on-disc.

In any consideration of the question of the superiority of one system over the other, it is only natural that the system with which we are most familiar will seem to be the best. However, from an impartial standpoint it may be stated that at the present time there is little real difference from a sound viewpoint between the two systems and from time to time improvements which are made on one system or the other tend to eliminate what differences there are remaining.

In conclusion it might be stated that had either system possessed advantages which were overwhelmingly superior to the advantages possessed by the other it is a certain fact that a wholesale adoption of the system would have been made by the major producers. The fact that both systems have remained in use throughout the sound era of motion pictures (and there is no indication of the abandonment of either system in favor of the other in the future) is sufficient commentary upon the equality of the two systems.

▲ ▲ ▲

Here are the answers

IN THE October issue of PROJECTION ENGINEERING, page 12, were presented ten elementary questions, to be studied and answered by projectionists.

It is to be understood that correct answers to a technical question might be submitted by a dozen students, each answer framed in different phraseology. In the following will be found the answers to questions 1 to 10, as submitted by one projectionist.

1. A device or system for reproducing sound from film or disc. In sound-on-film the sound pickup is an optical-electrical system contained in a compartment on the projector. In sound-on-disc the pickup is an electromagnetic device which transforms the physical variations in the grooves of the disc into electrical variations.

2. Alternating current is said to be synchronous, when exactly in phase and of the same frequency.

3. The specific gravity of the electrolyte is the most accurate guide to the state of charge of a lead-type battery. The test of the specific gravity is made by means of a hydrometer having a suitable scale for the type of cell to be tested. In all portable type batteries, and ordinarily in automobile batteries it is usually necessary to draw some of the electrolyte from the cell in order to test its specific gravity with a hydrometer which should have a scale reading of from 1150 to 1300.

4. If both disc and film equipment is installed, switch in whichever is to be tested first, by means of the film-disc switch. Put pickup equipment on one machine on turntable in circuit, by setting fader at point 9 on side to which this equipment is connected. If testing disc pickup, rub needle of reproducer with finger. The noise produced should be clearly heard in the monitor horn.

If testing film pickup, see that lamp current is at value specified, and readjust if necessary. Now take out tension pad and move a card up and down across the light spot. Every time this is done a click should be heard in the monitor horn. Finally replace light gate.

Move fader to the other side and test that pickup equipment in the same way. Bring fader to zero.

5. That amount of the force applied to a dynamo or other machine which turns it or causes its rotation. The mechanical rotary or turning force which acts on the armature of a dynamo-electric machine or motor and causes it to rotate. The pulling force which tends to rotate, as the rotating of a motor armature.

6. A. Low emission from the photoelectric cell. This is usually accompanied by a dropping off in quality also, resulting in harsh, tinny reproduction. Run the exciter lamp current up several tenths of an ampere until the volume is nearly normal, bring up amplifier gain. Replace the cell at the end of the reel.

B. Photoelectric cell window jarred out of position by the vibration of the projector. Remedy as above if possible and set back into correct position at first opportunity.

C. Exciter lamp jarred out of position, filament sagged, or dirt clogging aperture. Clean and adjust at end of reel.

7. Open or partially shorted reproducer. Check this with a pair of headphones across its terminals. If the volume is below normal replace the unit at the end of the reel.

8. Check rapidly, but in orderly routine, through the system—line fuse out, tube out in main amplifier, exciter lamp burnt out, defective pickup (reproducer unit) defective or burnt out tube in the photoelectric cell amplifier, shorted or open line on speaker circuit.

9. An induction motor which instead of having a single field winding, has two separate windings each taking current from a single phase circuit of the same frequency, but differing in phase by one-quarter period. A motor made to operate on two-phase lines.

10. Light. Sound travels at the rate of 1,100 feet per second (in air), while light travels at the rate of 186.000 miles per second.

American films— their moral influence‡

ALL motion pictures that touch on the commission of crimes show some form of punishment or restitution for criminal behavior. In January and February, 1931, 48 feature pictures were released by studio members of the Motion Picture Producers and Distributors of America and only 9 of these were the type of picture in which sex or crime had any degree of prominence. Of these latter 9 pictures, 8 received endorsement by one or more of the official reviewing groups in Hollywood, representing great national organizations including the D. A. R., the University Women's Association, Y. M. C. A., Federated Women's Clubs, the International Federation of Catholic Alumnae, etc.

The motion picture has brought the stage to millions who otherwise could never have hoped to visit Broadway. Our industry seeks constantly to raise the level of quality of its productions. Self imposed codes and standards of good taste have had much to do with the steady improvement in the quality of motion pictures. Hollywood is conscious of its responsibility and although it is no easy task to seek to please one hundred million people of various minds, yet Hollywood has found an increasing endorsement of its program on the part of those who register their opinion at the box office. Certain leaders of organizations representing a total membership of six and one-half million people are cooperating in a constructive movement for better pictures. Opposed to this group is an insignificant number of men and women who find nothing good in motion pictures and prefer their own intolerant standards and who seek through politics to dictate what the American public shall see and hear in their theatres. The motion picture does not glorify crime and the picture is rare in which violations of the accepted moral codes go without penalty.

The best proof of the ever increasing quality of motion picture plot and portrayal is found in the productions themselves which you have witnessed—in the dramas, epics and comedies shown in the current year.

Industry Realizes Its Responsibility

The motion picture is the American people's chief recreation at the close of the day's work. It is an antidote for the troubles and cares of the day, an inspiration for tomorrow, a tonic to renew ambitions, a bringer of laughs and of good cheer. The industry is conscious of the trust put upon it and is seeking to the best of its ability to live up to its responsibility as the holder of this magic tool which has come to be the eighth art.

From January to July in 1930 the representatives of those public groups which examine motion pictures in Hollywood, reviewed 607 new films. Out of the total 607 reviewed, 9 pictures out of every 10, or 86 per cent. of them won the endorsement of at least one group. These reviewers are shown motion pictures five mornings a week in the Academy studio and are free to make their own independent reports to their own national headquarters which in turn distribute them to group leaders throughout the United States.

We have been charged with corrupting the morals of foreign nations, yet the report of the Indian Cinematograph Committee published by the government of India Central Publication Branch in Calcutta in 1928 after hearing witnesses of all kinds from every part of India and Burma and after seeing a large number of films, stated that without exception the committee was satisfied that the overwhelming majority of films certified for public exhibition in no way tended to demoralize the Indian public or to bring Western civilization into contempt. This committee was created by act of the Indian Legislative Assembly.

American Films in China

Ronald Y. S. Cheng is one of the outstanding representatives of the New China in America. In his own country he has been the head of a training school for teachers and at the present time, at the behest of his government, he is studying the American school system and American and European theories of educational administration, at Teachers College, Columbia University. Mr. Cheng says: "In any case, China owes a great debt to American pictures. A vast population—four times that of the United States—is looking toward America for ideals. Your civilization fascinates my people. And they learn of you mostly through motion pictures.

"Turkey, so far as is known, neither has nor contemplates film censorship of any kind. It is true that a new municipal regulation in Istamboul (formerly Constantinople and no longer capital of Turkey) prohibits motion picture attendance for children under eight years of age. Nothing startling about that; similar police regulations are in force in many cities of our own country. In so far as the regulation applies to very young children, it applies to British, German and other films shown in Turkey. Nevertheless because a foreign newspaper abroad preferred to interpret this as a 'ban on American films,' an entirely false report is circulated to the whole world through the medium of an American publication."

‡*Address by Dr. Clinton Wunder, executive manager of the Academy of Motion Picture Arts and Sciences, before the Berkeley Women's City Club on the subject of "The Eighth Art."*

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Projectionists are studying

The series of technical examinations we are publishing monthly in PROJECTION ENGINEERING has attracted wide attention among the men who operate talking picture equipment in theatres.

Among the sets of answers submitted to the first ten questions we note that those who have turned in answers substantially correct are: William Richards, Calgary, Alberta; C. L. Merrill, Selmer, Tenn.; Carl M. Smith, Quantico, Va.; Frank Griesel, Regina, Sask.

Acoustics and its relation to seating in auditoriums

An Acoustical Analysis of a Typical Small Theatre

IT is the purpose of this analysis to apply the principles of acoustical correction to a representative small theatre, carrying out the analysis in detail and showing the various computations necessary.

Most acoustical troubles can be attributed to excessive reverberation of the sound in a room; in other words, its continued reflection back and forth in all parts of the room for too long a period of time before enough of its energy is absorbed by the objects it strikes to make it inaudible, and thus make clear way for succeeding sounds. The points that make for the proper distribution of sound energy are usually taken care of by the proper design of the room, such as sufficient slope to the floor to place listener in unobstructed line with the direct sound, avoidance of sharp curves and domes which might focus the sound energy, allowing enough opening between balconies and the floor below to allow sufficient sound to enter the covered part, etc. Even in cases where there does happen to be acoustical defects other than excessive reverberation, the reduction of the reverberation time to the optimum or satisfactory value for the room mitigates the other defects to where they are inoffensive.

The formula used is the familiar Sabine formula developed by the late Professor W. C. Sabine of Harvard University, which holds the following relationship:

$$t = \frac{.05V}{a}$$

where:

t = the reverberation time in seconds
.05 = a constant
V = volume of room in cubic feet
a = total absorption in the room

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A technical review of acoustic defects in theatres, and their treatment.

The problem is to reduce the reverberation time, t, until the hearing conditions become satisfactory. This is done by increasing a, the total absorption in the room, which in turn reduces t. Professor F. R. Watson of the University of Illinois has developed a table which gives the optimum or satisfactory reverberation periods for rooms of various volumes. If enough absorption be added in a room of given volume to reduce the reverberation time to the optimum or below, the hearing conditions will be satisfactory. Table I gives Professor Watson's optimum reverberation times corresponding to various volumes.

The total absorption in a room is determined by adding the absorption furnished by the various materials present in the room. Lists of coefficients of absorption of various wall materials and of the units of absorption furnished by various objects have often been published. A partial list of these coefficients is given in Table III.

The plan and longitudinal section of the theatre are shown in Fig. 1.

It is seen that the room compares favorably with the rules governing the good distribution of sound. A com-

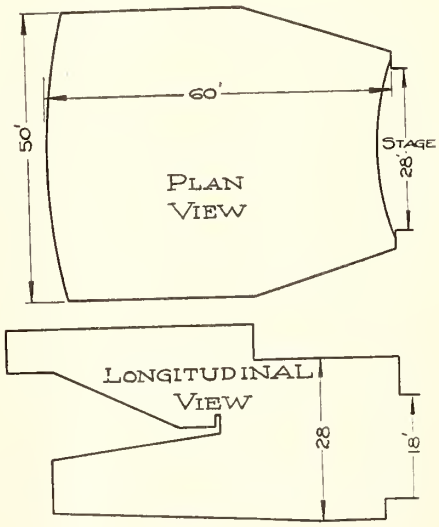

Fig. 1. Plan and elevation views of auditorium.

TABLE I

Sound Absorption Values of American Seating Company Theatre and Church Seating

	Total Units of Absorption at 512 Cycles as Determined by Bureau of Standards	Professor F. R. Watson
1. American plywood chair (No. 9152)...	.25	.24
2. American plywood chair with ¼ inch velour covered jute pad on front of back	.72	...
3. No. 8116 chair in imitation leather throughout. Box spring seat.....	...	1.6
4. No. 8116 chair. Back panel in velour. Seat, box spring, in imitation leather	...	1.7
5. No. 8116 chair in velour throughout. Spring edge seat..	2.5	2.3
6. No. 7080 chair in velour throughout. Spring edge seat..	...	2.7
7. No. 7080 chair in mohair throughout. Spring edge seat	3.0	2.8
8. No. 7080 chair in mohair throughout, with bottom of seat covered with ¾ inch acoustical felt covered with perforated steel panel...	3.3	...
9. No. 7180 chair in mohair throughout. Same as No. 7080 chair except steel panel on back of back instead of wood.....	3.0	2.9
10. Chicago Civic Opera House chair in mohair (special) Marshall spring back upholstered on both front and back sides. Spring edge seat. Upholstered side panels in the standards.	...	3.6
11. American loge chair. Fully upholstered in mohair	4.5	...
12. American oak pewing, bare. Per linear foot	.25	...
13. American oak pewing, bare. Per space allowed for one occupant (18 inches)	.38	...
14. American oak pewing, upholstered with three layers of cotton on front of back and top of seat, covered with velour. Per linear foot	1.3	...
15. Same as No. 14. except with BB Celotex one foot wide on under side of seat. Per linear foot	1.6	...

Absorption of Adult Persons Seated in Chairs and Pewing

1. Seated in No. 8116 chair in velour. Same chair as used in Test No. 5 above. Per person	4.07	...
2. Seated in No. 7080 chair in mohair. Same chair as used in Test No. 7 above. Per person	3.9	...
3. Seated in American oak pewing, upholstered. Same pewing as in test no. 14 above. Per person	3.3	...
4. Seated in American loge chair. Same chair as used in test No. 11 above. Per person	5.5	...

TABLE II

	Seconds
Below 7,000 cubic feet.....	1.0
7,000 to 20,000.....	1.1
20,000 to 45,000.....	1.2
45,000 to 85,000.....	1.3
85,000 to 145,000.....	1.4
145,000 to 225,000.....	1.5
225,000 to 330,000.....	1.6
330,000 to 465,000.....	1.7
630,000 to 835,000.....	1.9
835,000 to 1,100,000.....	2.0

mendable feature, not mentioned above among the necessary features for good distribution, is that of the under balcony ceiling. It will be noticed that this ceiling slopes from the front to the back being lowest at the rear wall. This causes the sound waves to be reflected from the ceiling to the benefit of those sitting in the rear seats, thus reinforcing the sound in this part of the house where it is often the most difficult to hear. There is nothing uncommon about the interior of the room. The walls are plaster on wood lath; the ceiling is plaster on suspended metal lath, and the floor is concrete. The average stage hangings are used. Seating capacity is 820.

The room is well adapted to satisfactory acoustical correction through the use of proper seating. This is true of most small houses. Special wall treatments, heavy drapes, or special floor treatments are very seldom needed. In the large houses these treatments fulfill a definite need and the quantity necessary is dependent upon the type of seating used. This fact will become apparent later in this analysis.

The volume of the room is 85,100 cubic feet. From Table II the optimum is found to be 1.4 seconds, which means that for satisfactory hearing, sound of standard uniform intensity and of frequency of 512 cycles per second must become inaudible, after the source of sound has ceased, in this length of time or less.

The absorption of the room empty, with no seating installed, is as follows:

Concrete floor
5825 square feet at .015 = 87 units
Ceilings, plaster on metal lath
5885 square feet at .033 = 194 units
Walls, plaster on wood lath
5606 square feet at .03 = 168 units
Stage opening 18 feet x 28 feet
504 square feet at .25 = 126 units
575 units

The reverberation period for such a condition is as follows:

$$t = \frac{.05V}{a} = \frac{.05 \times 85{,}100}{575} = 7.4 \text{ Seconds}$$

This reverberation period indicates that under such a condition, that is, the room empty with no seating, the hearing conditions would be very poor. The trail of sound following each syllable of speech or tone of music would linger so long as to make the succeeding syllables practically unintelligible. The addition of chairs to the room reduces this reverberation materially, the amount of the reduction depending upon the type of chair used.

First consider the use of plain plywood chairs.

Laboratory tests show these chairs to have an absorption of .25 units each (Table I, Item No. 1). The total absorption then in the room would be:

820 plywood chairs at .25 = 205 units
Absorption already in room = 575 units
Total with plywood chairs = 780 units

The reverberation period for the room with no audience present is then:

$$t = \frac{.05 \times 85{,}100}{780} = \frac{4250}{780} = 5.5 \text{ seconds}$$

It is customary, in order to give an idea of how the reverberation changes with increasing audience, to compute the periods for no audience, 1/3, 2/3, and maximum audience conditions. The absorption for an auditor seated is 4.0 units. Thus each person adds 4.00 —.25 = 3.75 units, since the absorption of the chair occupied has already been figured at .25 units.

Then for:

1/3 audience (273 people at 3.75 units)

$$t = \frac{4250}{(273 \times 3.75 + 780} = 2.4 \text{ seconds}$$

2/3 audience (546 people at 3.75 units)

$$t = \frac{4250}{(546 \times 3.75 + 780} = 1.5 \text{ seconds}$$

Max. audience (820 people at 3.75 units)

$$t = \frac{4250}{(820 \times 3.75 + 780} = 1.1 \text{ seconds.}$$

The curves in Fig. 2 illustrate graphically these, as well as later computations.

It is seen that through the low audience range the reverberation is far in excess of the optimum and that for the empty house it is approximately four times the allowable for good hearing conditions. The optimum is actually reached at about 600, or roughly, ¾ full house.

Next consider, in place of plywood chairs, chairs covered in imitation leather. These have an inserted panel back and a box spring seat. The absorption figure for the chair has been determined in the laboratory to be 1.6 units. (Table I, Item 3.) This, it will be noticed, is a considerable increase over the plain plywood chair, which is .25 units. Following are the computations involving this chair:

No audience: $t = \frac{4250}{(820 \times 1.6) + 575} = \frac{4250}{1885} = 2.3$ secs.

1/3 audience (273 people at 4.0 — 1.6 = 2.4) $t = \frac{4250}{(273 \times 2.4) + 1885} = 1.7$ secs.

2/3 audience (546 people at 2.4) $t = \frac{4250}{(546 \times 2.4 + 1885} = 1.3$ secs.

Max. Audience (820 people at 2.4) $t = \frac{4250}{(820 \times 2.4 + 1885} = 1.1$ secs.

The higher absorption of these chairs over the plywood has made a decided improvement in the hearing conditions. Optimum is obtained at less than 2/3 audience, and through the low audience range the reverberation is materially decreased Since auditors present 4.0 units of absorption seated in the types of chairs used in this analysis, the reverberation period for the house full will be 1.1 seconds in each case.

The ideal theatre, from the reverberation standpoint, would have a constant reverberation period regardless of the size of audience, this period being at or below the flat optimum line (Fig. 2). The proper chairs tend to actually bring this condition about, and without the use of other treatments. The sound absorption built into the chairs is so designed and placed that it is cancelled when the chairs are occupied, the absorption of the chairs being replaced by that of the auditors occupying them, keeping the absorption from mounting rapidly, thus tending to maintain more uniform sound conditions or a flatter curve in Fig. 2. In any theatre re-

TABLE III

Coefficients of absorption for a few commonly used materials taken from the works of Professor W. C. Sabine, Professor F. R. Watson, and the Bureau of Standards. They are for the standard frequency of 512 cycles per second.

	Units Per Square Foot
Open window	1.00
Plaster on metal lath	.033
Plaster on wood lath	.03
Concrete	.015
Glass, single thickness	.027
Wood, varnished	.03
Wood sheathing	.06
Linoleum	.03
Carpets	.15 to .29
Drapes in heavy folds	.50 to 1.00
Stage openings, depending on hangings	.25 to .50
Commercial wall treatments... (Plaster, boards, felts, etc.)	.03 to .74

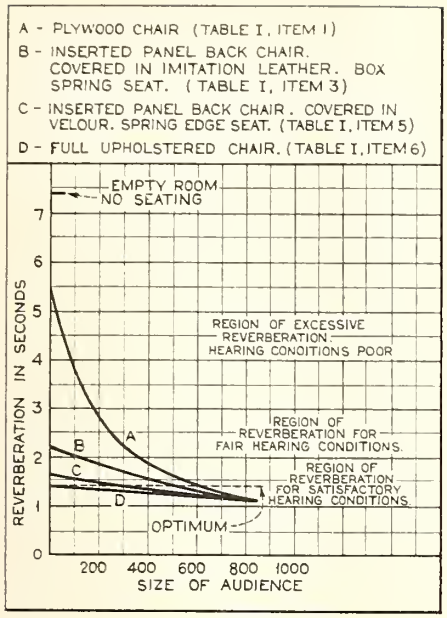

Fig. 2.

gardless of the size, the highly absorptive chairs will produce the flatter curve, but in the case of the large house additional absorption, in the form of wall treatments, etc., is necessary to bring the flatter reverberation curve down into the optimum region, or lower portion of the graph (Fig. 2). This additional absorption, as has been previously pointed out, is not necessary in the case of the small house.

The layman does not quickly grasp the advantage of the flat reverberation curve. The flat curve means, however, that there is not undue modulation or change of the sound conditions with changing audience. The early comers to the first show are surrounded by the same conditions as far as sound is concerned as when the house is full, and hearing conditions are consequently the same. The projection machine operator is not required to make fader adjustments to compensate for increasing absorption due to increasing audience. Also, his log sheet made at rehearsal conforms to actual performance conditions.

The first two sets of computations indicate only in a small way the correction that can be obtained through chairs. The first of the following computations uses a chair similar to the last one used in foregoing computation except that the covering material is velour instead of imitation leather and the seat is of spring edge construction. Due to the changes made in the covering material and seat construction, the absorption has been increased to 2.5 units as determined in the laboratory (Table I, Item No. 5).

No audience:

$$t = \frac{4250}{(820 \times 2.5) + 575} = \frac{4250}{2625} = 1.6 \text{ seconds}$$

1/3 audience (273 people at 4.0 — 2.5 = 1.5)

$$t = \frac{4250}{(273 \times 1.5) + 2625} = 1.4 \text{ secs.}$$

2/3 audience (546 people at 1.5).....

$$t = \frac{4250}{(546 \times 1.5) + 2625} = 1.2 \text{ secs.}$$

Max. audience (820 people at 1.5).....

$$t = \frac{4250}{(820 \times 1.5) + 2625} = 1.1 \text{ secs.}$$

These chairs give optimum at 1/3 audience, which is the audience for which correction is usually applied in theatres. The curve drawn from these figures is much flatter and lower than either of those for the other chairs, and this, of course, is desirable. Even at no audience the reverberation is within .2 seconds of optimum.

The last computations give still more perfect conditions. It consists of velour or mohair covering material, a full upholstered back, and a spring edge seat. Its absorption is 3.0 units as determined in the laboratory (Table I, Item No. 6).

No audience:

$$t = \frac{4250}{(820 \times 3.0) + 575} = \frac{4250}{3035} 1.4 \text{ secs.}$$

1/3 audience (273 people at 4.0 — 3.0 = 1)

$$t = \frac{4250}{273 + 3035} = 1.3 \text{ secs.}$$

2/3 audience (546 people at 1.0) t.....

$$= \frac{4250}{546 + 3035} = 1.2 \text{ secs.}$$

Max. audience (820 people at 1.0) t.....

$$= \frac{4250}{820 + 3035} = 1.1 \text{ secs.}$$

This gives the best correction of the four chairs used. Under no audience condition is the reverberation period above the optimum, consequently hearing conditions are good at all times.

These examples bring out the possibilities of acoustical correction through the seating. Each theatre is a case unto itself, acoustically, and each should be carefully analyzed to determine the type of seating required to give the desired results. What is desired is uniform reverberation time in the region of the optimum throughout the entire audience range. A balancing factor is required to obtain this and the balancing factor is found in the proper seating, scientifically designed, and with the proper distribution and kinds of absorption materials to keep the auditors from materially increasing the absorption in the room.

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New president of S. M. P. E.

DR. ALFRED N. GOLDSMITH, vice-president and general engineer of the Radio Corporation of America, has been elected President of the Society of Motion Picture Engineers.

Dr. Goldsmith succeeds J. I. Crabtree, retiring president, and will hold office during 1932. The headquarters of the Society are in New York.

Dr. Goldsmith's election evidences the increasingly close relationship between the radio industry on the one hand and the sound motion picture industry on the other, as he formerly served as president of the Institute of Radio Engineers. He has also served as Chairman of the Ways and Means Committee of the Society of Motion Picture Engineers. Dr. Goldsmith delivered the president's address before the convention at Swampscott, Mass., on October 7.

Since the early days of radio communication, Dr. Goldsmith, who has been recently appointed to the Board of the American Standards Association, has been closely associated with that field and other fields employing similar engineering methods for the recording and reproduction of sound. Throughout the development of radio he has remained a specialist in the industrial utilization of electromagnetic waves and in the development of electro-acoustic devices.

He conducted the radio research laboratory and taught electrical engineering in the College of the City of New York from 1907 to 1917. At that time he became consulting engineer for the General Electric Company, and later director of research for the Marconi Wireless Telegraph Company of America.

In 1919 he joined the Radio Corporation of America, first holding the post of chief broadcast engineer until recent years, when he was appointed vice-president and general engineer. He was vice-president in charge of engineering of RCA Photophone for some years after the formation of that organization, and was closely associated with the development of its sound motion picture equipment.

Dr. Goldsmith is a Fellow and past president of the I. R. E.; active member of the S. M. P. E.; Fellow of the A. I. E. E., and a member of other technical organizations.

Magnetic pickups and loudspeakers

By E. W. Kellogg*

IN the March, 1931, issue of Projection Engineering, appeared an article entitled "Pickup Possibilities," by S. McClatchie, which is one of the best reviews of phonograph pickup development that I have seen. The article opens with the statement that in the five years since the first commercial model appeared, the magnetic pickup "has seen surprisingly little development."

This might be interpreted as implying that pickup design had had rather scant attention during this period, but everyone who has been in touch with the radio industry knows that such is not the case. As the one responsible for the original design, I cannot refrain from pointing out the other interpretation. The improvements which have been made, have been details of design, manufacturing methods and materials, but the general form of the first model has been retained.

Does this not mean that the original design was very nearly the best of the possible forms? In an A.I.E.E. paper[1] describing the original development I reviewed most of the forms which seemed worth considering, and gave what appeared to be adequate reasons for the choice made. One of the most important arguments for the arrangement adopted, was that it permitted the placing of the needle clamp screw in the axis of rotation, where it added very little to the armature inertia. Perhaps I did not adequately discuss the moving-coil type, or the type in which a magnetic armature moves in such a direction as to vary the area instead of the lengths of the air gaps.

I understand that high quality pickups have been made employing the moving-coil principle, but the structural or mechanical problems are more difficult than with an iron armature, and a stronger field magnet is needed if output is not to be sacrificed. The variable area air gap design results in an awkward shaped armature if it is to deliver the same output as the design now used, and its chief merit, namely, the possibility of extreme flexibility, does not seem to outweigh the disadvantage mentioned. In other words, sufficient flexibility can be maintained in pickups with variable length air gaps (by using long gaps for example) and the output is still above that of a variable area model with an equally light armature. The Marconi pickup shown in Fig. 6 of Mr. McClatchie's article looks something like a variable area design, but it is not.

I fully expect to see new forms of pickup, especially where some increase in expense can be permitted for the sake of improvement in quality of reproduction, and the importance of improvements in details of design, materials, and methods of manufacture should not be minimized, but on the other hand, the choice of design in the first model seems to have been justified by subsequent experience.

Mr. McClatchie contrasts the radical changes in loudspeakers during the past five years with the small changes in pickup design. But if we consider the "dynamic cone" type of speaker, its history is similar to that of the pickup. Like the pickup, the dynamic cone speaker was the outcome of an extended theoretical and experimental study. The story of this development is told in a 1925 A.I.E.E. paper[2] by Chester W. Rice and myself. The two devices were made available to the public at very nearly the same time, in the Radiola No. 104 loudspeaker and in the Brunswick Panatrope. Many variations have been tried in the loudspeakers but no major improvements have been made over the model first described by Rice and myself. Probably the most important improvement was the corrugation of the cone, which reduced an objectionable resonance and at the same time stiffened the cone so that it held its shape better.

The difference in the history of the pickup and the loudspeaker, is that the pickup, when it was introduced, had the field to itself, while the loupspeaker entered a highly competitive field. What has appeared like an evolution of loudspeakers since 1925 from horns, to cones with magnetic armature motors, and to dynamic cones, as mentioned by Mr. McClatchie, has been the gradual supplanting of the two other types by the dynamic cone, until today it is in all but universal use as a household radio loudspeaker.

Those of your readers who are interested in these design problems might like to refer to the two papers I have mentioned. There is another paper I should like to add to the list, namely one describing the development of the type PR-4 Photophone recorder.[3] While the design problems are of a different nature, I am told that in the year and a half since the first of these machines went into service, those who have been using them have not wanted to rebuild them.

If there is any moral to these reflections, it would be that whenever it is possible by careful study and experimenting to crowd the evolution of a device into the period prior to its manufacture, the design is likely to stand the test of time, and the public benefits by less obsolescence.

*Engineering department, RCA-Victor Company.

[1] "Electrical Reproduction from Phonograph Records," Edward W. Kellogg, Trans. A.I.E.E., Vol. 46, P. 903, 1927.

[2] "Notes on the Development of a New Type of Hornless Speaker," Chester W. Rice and Edward W. Kellogg, Trans. A.I.E.E., Vol. 44, P. 461, 1925.

[3] "A New Recorder for Variable Area Recording," Edward W. Kellogg. Jour. S.M.P.E., Vol. XV, No. 5, 1930.

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Inventor of these devices discusses their evolution and improvement

MORE QUESTIONS

HEREWITH are submitted questions 11 to 20, following the first ten submitted in the October issue of Projection Engineering. The answers to questions 1 to 10 are given in this (November) issue, and the answers to questions 11 to 20 will appear in the December issue.

11. What is meant by chromatic aberration?
12. What is meant by the equivalent focus of an objective lens?
13. Name a few causes of out-of-focus effect.
14. Is sound a wave motion?
15. Does sound like light travel in straight lines?
16. A. Does sound travel at the same rate of speed in different media? B. Does sound travel faster through air than through iron?
17. Define Ohm's law and state how it works.
18. Define a watt, a kilowatt, a volt, a short circuit.
19. What is meant by reverberation?
20. What is remote control?

Educational sound motion pictures

By Dr. Alfred N. Goldsmith*

Improvements in the effectiveness of education with possible economies, should follow if the new facilities are thoroughly studied

DR. ALFRED N. GOLDSMITH

THE present position of educational sound motion pictures is rather peculiar. On every hand one hears a great deal about the marvelous capabilities of sound motion pictures when applied to educational purposes. One also hears of elaborate researches and experiments in the production of these pictures which are being conducted by responsible organizations.

In startling contrast, the utilization of sound motion pictures in the average school, high school, or university, seems to be conspicuous by its absence. Otherwise stated, many people are much interested but relatively little happens as a result of their interest. As Mark Twain once said about the weather, "Everyone complains about it but no one ever does anything about it." To what may be ascribed the relatively slow acceptance of sound motion pictures in the educational field? Unquestionably the editor of "Projection Engineering" in a recent editorial[1] has clearly explained one limiting factor. Until educational pictures prove themselves a more effective *and economic* method of education in certain respects than that now current (even if only in an auxiliary capacity), they can hardly be expected to appeal to prudent school boards and to worried tax payers.

This is, however, another aspect of the situation which must be considered. So far as educational sound motion pictures are concerned, probably the first thing that must be done is "to educate the educators." Educators, for some mysterious reason, have been waiting for engineers, producers of entertainment films, large industrial corporations, and the like, to produce learned and effective educational pictures. It is hardly astonishing that these agencies have rarely hit the bull's eye in their attempts to produce such pictures. It is perhaps putting the cart before the horse to expect the application of this new medium, the sound motion picture, to educational purposes to originate in other than educational quarters.

A Method of Inquiry

Let us imagine the reverse procedure for a moment. Conceive of a group of eminent educators, specialists in some division of learning, carefully studying the production of sound motion pictures. Let us imagine these gentlemen learning of the possibilities and the limitations of the new medium, of studio technique, and methods of sound and picture reproduction in the school or college. Let us imagine them jointly preparing educational continuities or scenarios covering auxiliary materials suitable for use in connection with instruction in their particular subject. Imagine this material being circulated among their fellow teachers and submitted also to the criticism and comment of leading educational societies. Assume that this material is then carefully filmed, utilizing the services of skilled demonstrators, actors, studio staff, and other necessary personnel and, above all, imagine this work adequately financed by some educational foundation, group of universities or schools, or even, in part at least, by certain industrial organizations.

Is it not likely that the film thus produced would be more serviceable in the schools, less biased, more readily acceptable, and altogether more satisfactory than those prepared by individuals or single organizations?

It has taken many hundreds of years for the teachers of the world to learn how to write good text books. The art of printing has not been fully applied in the educational field, even at this late date. It is certainly too much to expect that sound motion pictures will become equally useful in the educational field until long and painful experimentation on the part of the educational workers of the world has led to their mastery of the new medium.

If, therefore, it were desirable to make a single recommendation which might most advance the advent and successful employment of sound motion pictures in the schools, it would be that the teachers should begin carefully and systematically to study the new medium and should, with proper support, experiment in its use. Great improvements in the effectiveness of education and possible economies in its administration might well result.

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Resistance Conversion Factors

To change ohms to megohms, divide ohms by 1,000,000.

Example: 25,000 ohms = .025 megohms.

To change megohms to ohms, multiply megohms by 1,000,000. Example: .025 megohms = 25,000 ohms.

*Vice-President and General Engineer, Radio Corporation of America.

[1] September, 1931.

Nitrocellulose motion picture film

The regulations of the National Fire Protection Association for the handling and storage of motion picture film, as here presented, have been voted upon affirmatively by a majority of the association's committee covering this subject.

(*Concluded from September issue of* PROJECTION ENGINEERING)

Section 19. Motion Picture Projection and and Special Processes

191. Enclosures for Motion Picture Projectors. (a) Motion picture projectors using nitrocellulose film shall be operated or set up for operation only within an approved enclosure, not less than 48 square feet in size and 7 feet high. If more than one machine is to be operated an additional 24 square feet shall be provided for each additional machine.

(b) The enclosure shall be built of brick, tile, or plaster blocks, plastered on both sides, or of concrete, or of a rigid metal frame, properly braced, and sheathed and roofed with sheet iron of not less than No. 20 U. S. gauge metal, or with ¼-inch hard asbestos board, securely riveted or bolted to the frame, or 2 inches of solid metal lath and cement or gypsum plaster. All joints shall be sufficiently tight to prevent the discharge of smoke.

(c) The entrance door into the enclosure shall be at least 2 feet by 5 feet, of construction equivalent to the sheathing permitted above for rigid frame construction, and shall be so arranged as to close automatically, and shall be kept closed at all times when not used for egress or ingress.

(d) Two orifices or openings for each picture machine may be provided; one for the operator's view shall be not larger than 10 inches by 20 inches; and the other through which the picture is projected shall be not larger than 8 inches in greatest dimension. Where separate stereopticon, spot or flood light machines are installed in the same enclosure with picture machines, they shall be placed so as to be at least 5 feet away from any picture machine, and not more than one opening for each machine shall be provided for both the operator's view and for the projection of the light, but two or more machines may be operated through the same opening; such openings shall not be greater than 1080 square inches for each such machine accommodated.

(e) Each opening shall be provided with gravity shutter of approved fire-resistive material. Shutters shall be suspended, arranged and inter-connected so that all openings will close upon the operating of some suitable fusible or mechanical releasing device, designed to operate automatically in case of fire or other contingency requiring the immediate and complete isolation of the contents of the enclosure from other portions of the building. There shall also be provided suitable means for manually closing all shutters simultaneously from a point near the door. Shutters on openings not in use shall be kept closed.

(f) All shelves, furniture and fixtures within the enclosure shall be constructed of incombustible material, and no combustible material of any sort whatever shall be permitted or allowed to be within such enclosure, except the films used in the operation of the machine.

(g) Ventilation shall be provided by means of a vent pipe having inlets at one or more points in the ceiling and also connecting to each arc lamp housing. The vent pipes shall lead to the outside of the building or to a special non-combustible flue. All vent pipes shall be kept at least 1 inch from combustible material or separated therefrom by approved non-combustible heat insulating material not less than ½ inch in thickness.

Draft in each booth vent pipe shall be maintained by an exhaust fan having a capacity of at least 200 cubic feet per minute for each 80 square feet of floor area of the booth.

Note: Automatic sprinklers in projection booths have been very successful in controlling fires and reducing losses. and their installation is recommended wherever practicable.

192. Not more than 5 motion picture projectors shall be located in one room, unless the projectors are of a type using incandescent electric lights of not over 25-watt size when not more than 10 projectors shall be located in one room.

193. Processing of Film. The processing of film, as cleaning, polishing, buffing and other special treatments shall not be located in rooms with other operations. Special processes for treating film shall be provided with such proper safeguards as are necessary for protection against the hazards involved. The inspection department having jurisdiction shall be consulted in regard to the protection needed.

194. Soldering cases. Soldering cases of film is a hazardous process, and when done in a building shall be conducted in a room used for no other purpose. Walls of the room shall be constructed of 6 inches hollow tile plastered each side to a thickness of ½ inch or its equivalent. Area of room shall not exceed 60 square feet. Opening to room shall not be from another film handling room; it shall be protected by an approved self-closing Class B fire door. Automatic vent shall be provided with a ratio of 70 square inches for each 500 pounds of film. Room shall be equipped with automatic sprinklers with a ratio of one sprinkler for each 15 square feet with proper sheet metal baffles. Quantity of film in room shall not exceed one case.

Note: The use of shipping cases with metal linings of the telescope type which do not need to be soldered, is recommended.

195. Silver reclaiming. The process of reclaiming silver from film shall not be carried on in a building with other processes unless cut off therefrom by standard fire walls. Such sections shall be completely equipped with automatic sprinklers.

196. Film cement. Compounds of collodion, amyl acetate or similarly flammable cements shall not be kept in the rooms where they are used, in quantities greater than 1 quart; any such material in excess of this quantity shall be kept in a vault. The use of these materials in motion picture theatres and other special occupancies is covered in sub-section 214.

197. Smoking. Smoking should be prohibited in any establishment handling or storing film, and conspicuous "No Smoking" signs should be posted in prominent places. Matches should not be carried by any employee.

Part II. Special Provisions for Special Occupancies

Section 21. Motion Picture Theatres and Other Occupancies in which the Principal Use of Film is in Motion Picture Projection

211. Motion picture projectors shall be installed in a booth in accordance with sub-section 191.

212. Rewinding of films shall be performed in a separate room at an approved location, of construction specified in sub-section 112, and with a vent to the outside of the building of not less than 27 square inches, or may be performed in the projection booth.

213. Care and use of film. Motion picture film used in connection with the projection of motion pictures (as in theatres, motion picture theatres, screening or projection rooms, sound recording studios, and motion picture titling studios) shall be limited and kept as follows:

(a) The quantity of film in any projection booth or rewinding room not equipped with an approved system of automatic sprinklers shall be limited to that given below; if equipped with an approved system of automatic sprinklers, double the quantity specified may be permitted.

(1) In a projection booth or room, constructed of brick, hollow tile, concrete or other approved masonry, not exceeding 125 pounds (25,000 feet of 35 mm. film);

(2) In a rewinding room constructed of brick, hollow tile, concrete, or other approved masonry, separated from projection room with openings thereto protected with approved fire doors, not exceeding 125 pounds (25,000 feet of 35 mm. film);

(3) In a projection booth or room, constructed of metal frame covered with asbestos board or sheet iron, not exceeding 75 pounds (15,000 feet of 35 mm. film);

(4) In a special room constructed and vented as required for rewinding rooms (see sub-section 212), when approved by the inspection department having jurisdiction, not exceeding 125 pounds may be kept in lieu of the amount permitted in either the projection booth or the rewinding room. The total quantity in the three rooms shall not exceed 250 pounds (50,000 feet of 35 mm. film).

(b) The above quantities of film shall be kept as follows:

(1) Up to 40 pounds (8,000 feet of 35 mm. film) of film may be kept in Interstate Commerce Commission shipping containers, or approved cabinet in each room;

(2) If the amount of film, on hand exceeds 40 pounds, an approved cabinet shall be provided, in which the amount of film in excess of 40 pounds shall be kept.

214. No collodion, amyl acetate or other similar flammable cement or liquid in quantities greater than ½ pint shall be kept in the projection booth or rewinding room.

215. Location. The number and location of motion picture projection rooms or booths in any non-sprinklered building shall be subject to the approval of the inspection department having jurisdiction.

Section 22. Motion Picture Film Exchanges

221. Buildings not of fire-resistive construction, housing an exchange, shall be completely equipped with automatic sprinklers. Buildings of fire-resistive construction shall be equipped from and including the lowest floor on which film is handled to the top of the building with an approved automatic sprinkler system. It is recommended that the sprinkler system extend throughout the building.

222. Exchanges shall be provided with one or more independent rooms to be used exclusively for receiving and delivering film, and also one or more separate rooms for the purpose of inspecting, examining and repairing film, and one or more rooms for the storage of posters or other combustible materials.

223. Shipping room. One or more vaults or cabinets shall be provided in connection with the receiving and shipping room of exchanges into which all film shall be placed and kept except during such time as is necessary for checking, sorting and shipping. All film outside the vaults and cabinets, except while actually being handled, shall be kept in I. C. C. containers.

Note: With the enforcement of the above general principles of operation, the total quantity of film, including what is in I. C. C. containers, in the receiving and shipping room of any exchange should ordinarily not exceed 100 to 150 rolls, with a maximum limit which should never be exceeded of 300 rolls or 1,500 pounds.

224. In inspection, projection, rewinding, and other rooms (not including shipping room) there shall not be in excess of 15 rolls of film for each person handling film in such rooms, of which not in excess of two rolls for each person shall be exposed outside of closed containers. All film in excess of this quantity shall be kept in cabinets or vaults.

Section 23. Motion Picture Film Laboratories

231. All buildings used for, or housing a motion picture film laboratory shall be equipped throughout with automatic sprinklers.

232. In all the various work rooms in which film is handled (not including shipping rooms) the quantity of film not in containers shall not exceed two rolls per person handling film; this should not be construed, however, as restricting the quantity of film which may be in process on printing, developing or drying machines to two rolls. There shall not be more than 10 rolls of film not in approved cabinets for each person working in such rooms; provided, however, that in developing rooms there shall not be more than 20 rolls of film not in approved cabinets for each developing unit. All film in excess of the above quantities shall be kept in vaults.

233. Printing. Unless printing machines are so spaced that the distance from the film on any machine to that on any other machine is at least six feet, they shall be separated from each other by incombustible partitions of ⅜-inch hard asbestos board or its equivalent in heat insulation and durability, and extending from the floor to at least 3 feet above the top of the film on the machines. If partitions carried to this height would extend higher than 2 feet below sprinkler deflectors, they shall be built up to the ceiling. If partitions are extended to the ceiling one sprinkler head shall be located in each of the sections thus formed. In any event, sprinklers shall be so arranged that not more than two machines are dependent upon the protection afforded by any one head.

234. Drying machines of the cabinet type shall be of metal and wired glass. Heating units shall be located outside the cabinet, and shall be provided with thermostatic control so that the temperature in the cabinet shall not exceed 110° F.

235. Waxing. Waxing film shall be done in a separate room. Waxing processes which require the waxed film to be left exposed to dry shall be in a room used for no other purpose and not

STANDARDIZATION OF APERTURES FOR SOUND PICTURES

In the December issue of Projection Engineering *will appear the proposed specifications for standard aperture arrangements now being studied by studio staffs and soon to be presented to theatre and release organizations for consideration and approval.*

over 5 such machines shall be located in one room. Not over 25 rolls or 25,000 feet of film shall be exposed at one time.

236. Shipping room. (a) The shipping room shall be separated from the rest of the building by partitions constructed in accordance with the provisions of sub-section 112. No other process than packing of film shall be conducted in the shipping room.

(b) Shipping rooms shall be provided with one or more vaults in connection therewith, into which all film ready for shipment shall be placed until the time it is actually to be packed. With the use of such vaults the quantity of film not in shipping cases should never exceed the number of rolls which are to go into the cases being packed, which shall not be in excess of one case per shipping clerk.

Section 24. Motion Picture Studios (See Part I General Provisions which also apply.)

241. Buildings housing motion picture studios shall be completely equipped with automatic sprinklers, except that upon specific approval of the inspection department having jurisdiction, sprinklers may be omitted in rooms used only for housing valuable electrical equipment and in which no film or other hazardous materials are handled or stored.

Note: For sound recording studios and motion picture titling studios see also Section 21.

242. (a) On the studio stage there shall be no film except in the magazines of cameras or sound recording apparatus of which there shall not exceed two magazine units for each camera or recording apparatus.

In other sections of a motion picture studio the quantity of film not in containers shall not exceed one roll per person handling such film.

(b) Extra, loaded magazines may be kept in a special magazine room. The number of loaded magazines in one such room shall not exceed 50. They shall be kept on open metal racks. Such rooms shall be used for the loading and storing of magazines only.

(c) In all sections of a motion picture studio other than the stage and magazine rooms, the quantity of film in a room shall not exceed 10 rolls per person handling film, in addition to what may be kept in cabinets.

(d) All film in excess of the quantities permitted above shall be kept in cabinets or vaults.

243. Vaults and / or cabinets shall be located in a section separated from the studio stage by partitions. (See subsection 112.)

244. Sections of a studio in which the work is of the same general character as that in a laboratory shall be governed by the provisions of Section 23 Laboratories.

245. Carpenter shops, property storage rooms, costume rooms, and dressing rooms shall be separated from the studio stage by fire partitions constructed of 8 inches of brick, or of some other construction of incombustible materials and suitable stability, having a fire retardant classification of not less than 2 hours as determined by the Standard Fire Test.

246. Materials constituting a permanent finish or interior surfacing on ceilings, permanent partitions and walls, and used to reduce the reflection or transmission of sound, shall, if not incombustible, be or treated so as to be of an approved slow burning composition or character.

247. All fabrics of monk's cloth, canvas, muslin, burlap, silk, satin, velvet, velour or similar material suspended from ceilings or gridirons or hanging against walls or partitions, and all back drops, cycloramas and other theatrical appurtenances constructed in whole or in part of muslin, canvas, burlap, and all artificial or natural trees, shrubbery, grass mats, straw, hay and similar combustible material shall be painted, sprayed or saturated with fire-retarding or flame-proofing material or otherwise rendered safe against fire; provided, however, that furnishings of silk, satin, velvet and velour which are used in sets and included in the photographing of scenes need not be so treated.

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The camera and the eye*

By Dr. Park Lewis

UNDER normal physiological conditions, moving pictures do not cause serious eye fatigue. Since viewing moving pictures is distant vision, it does not demand so great an ocular effort as near vision—such as reading for a corresponding length of time. When eyestrain is caused by moving pictures it is due to one or another preventable condition, such as too prolonged fixing of the attention on a single point, or defective visual function, to a bad position of the observer in relation to the screen, to poor films, improper manipulation of the apparatus, to faulty projection or to improper illumination. With these reservations there is no more harm to the eyes in viewing the moving pictures with modern improved methods than there is in any other normal use of the eyes.

In a recent inquiry which was instituted by Professor De Feo of Italy and presented to the League of Nations, opinions were secured from leading eye physicians throughout the world. The agreement was general in the views expressed. There are four elements to be considered in an inquiry as to whether moving pictures can in any degree be injurious to the eyes of the observer. These have to do with the quality of the film, with the arrangement of the lighting and the mechanism of the motion, and with the position of the observer. The final and important requirement is that his own eyes shall function normally.

Proper Screen Illumination

The first requisite is that the screen picture shall be clear and distinct. The captions and other descriptive matter accompanying the view should be sufficiently large to be easily read and not so redundant that the reading may not be easily completed before it disappears. That the film may be clearly shown depends on several elements. The first is the illumination. This should be adequate but not glaring. A glare is an excess of unfocused light; a sharp unshielded bundle of light rays coming from one side or the other or reflected from the screen itself, or from an unshaded light bulb in the dimness of the playhouse, will cause unnecessary discomfort.

The arrangement of the scene itself so that glaring reflections are thrown back on the audience is now of infrequent occurrence, as the good producers are employing the assistance of the best artistic and illuminating engineering talent. It is better that the hall in which the picture is shown be not too dark. Strong contrasts of light and darkness are not pleasant and the details of the picture are brought out with even greater clearness in a twilight atmosphere if there are no distracting light sources visible. It is imperative that the film be run through with just the right degree of rapidity to make the images stand out and to move with the deliberation of actual living people.

The beauty as well as the eye comfort of what might otherwise be an exquisite picture is often ruined by the rapidity with which it is shown. In the exhibition of an instructive picture recently shown in an educational institution of high standing a current of twenty-five instead of sixty cycles was

*In the September issue of the Sight-Saving Review.

used. This, together with some fault in the motor mechanism, caused a constant flickering of the light that gave the impression of a picture seen through falling water. The sensation produced was most uncomfortable and soon became fatiguing. The whole effect of the picture was thereby lost and the illusion destroyed.

It is also important that films be retired from service after a reasonable amount of use. When they become spotted and cracked either from the heat of the lamp or from too long continued use, they give blurred and indistinct impressions and are neither attractive nor comfortable to look upon. In some of the cheaper picture houses they are used much too long.

The position which the observer occupies in relation to the screen contributes very much to the eye comfort. If he is too close to the screen the pictures become blurred and confused, and defects are emphasized. The same effect is produced if the picture is viewed from too great an angle from one side or the other. Sometimes nearer, inferior seats are cheaper and are occupied by children whose eyes are more easily harmed by the resulting strain than would be the eyes of older people. Children should not be allowed to occupy these less desirable positions. The best place from which the picture can be viewed is near the center of the hall and directly in front of the screen.

The final requirement, if the film is to be seen without discomfort, is that the eyes of the observer shall be functionally normal and of good visual acuity. When in the absence of any of the defects above mentioned—in the screen, in the evenness with which it is shown, in the illumination and in the position of the observer—there is still a consciousness of strain which is not occasional but persistent, it is safe to assume that there is present some ocular defect that should be corrected. It may be focal or muscular, but it will be found that any other continuous use of the eyes will be equally discomforting. In that event, the eyes should be examined in order that the defect may be found and corrected and the prescribed glasses worn.

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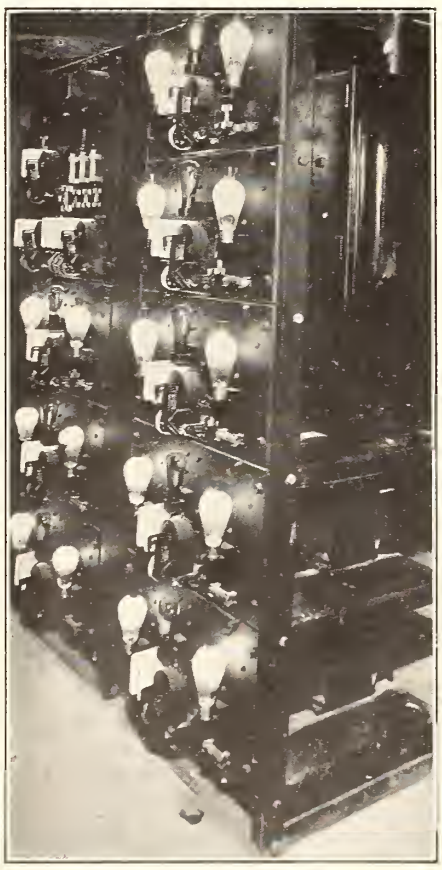
Thyratron reactor lighting control enters movie theatre field

THE first application of Thyratron-reactor theatre lighting control to a house devoted strictly to the production of motion pictures has been made in a new RKO theatre in Schenectady, N. Y., which opened August 28. This lighting control scheme, which eliminates the bulky backstage switchboard and makes the manipulation of the control a matter of extreme simplicity, found its first application in the Chicago Civic Opera House. A modified form was installed in the new Earl Carroll Theatre in New York, just opened, and RKO, in addition to the new Schenectady theatre, will install the system in new theatres in Albany, N. Y., and Denver, Col., to open in October and December, respectively.

Thyratron tubes are the basis of the new control scheme. By shifting the phase relationship between the elements in the tube, the average amount of rectified current passed by the tubes is varied, governing the intensity of the lights. By splitting the lights into various circuits, various groups can be controlled individually, and related groups of circuits can be controlled collectively through master circuits.

The new Schenectady theatre, being designed for the production of motion pictures only, has but ten major lighting circuits, six on the stage and four in the auditorium. The stage lights are divided into three colors: white, red and blue, with one control for each color in the footlights and borders. In the auditorium but one color is used, with a circuit control for the fixtures, two for the ceiling and another for the niches and receptacles. A novel addition to the lighting scheme is a "panic" control, by means of which the full brilliance of all the lights in the theatre can be turned on instantly by the flick of a single switch, no matter what complex lighting effects might be in progress at the time.

The Albany and Denver theatres will be built for both motion pictures and vaudeville and will, therefore, involve a larger number of lighting circuits. There will be 48 circuits in the Albany theatre. Denver is expected to have 45.



Control panel and reactor rack, showing arrangement of electron tubes.

A great deal of interest has been aroused by the installation in the new Earl Carroll theatre. Here the lighting director sits in a booth in front of the curtain, near the orchestra railing where he can observe the lighting effects he produces. There are 50 lighting circuits, 34 on the stage and 16 in the house, all controlled through the medium of the new control "console."

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RESISTANCES IN PARALLEL

$$Rt = \frac{1}{\frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3} \text{ etc.}}$$

If the resistances are all of the same value, the total resistance will be equal to the resistance of one divided by the number connected in parallel.

The total resistance of resistors connected in series parallel is found by separating them into groups, finding the resultant resistance of each group and reducing the network into a series of resultant resistances, after which the total resistance of the network can be determined.

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Effect of Temperature on Wires

The effect which extreme difference of temperature has upon the resistance of telephone and telegraph wires may be understood when it is stated that between 100 degrees F. and 22 degrees Fahrenheit, copper wires decrease 18 per cent. in resistance and iron wire 26½ per cent.

Highlights of the Report of the Progress Committee of the Society of Motion Picture Engineers

(Presented before the Society at Swampscott, Mass., Oct. 5, 1931).

E. I. SPONABLE,
Vice-President, S.M.P.E.

Films and Emulsions

Interest in the adoption of wide film, though dormant for the past six months, is expected to be aroused again with the return of normal economic conditions. The high speed panchromatic emulsions introduced earlier in the year have been given exhaustive trial under the severe working conditions prevailing in the studios, both in this country and abroad. General satisfaction has been expressed by the trade on their characteristics. Huse has described a panchromatic film which has the emulsion coated on a support having a neutral gray density of 0.2 which is claimed to minimize trouble from halation.

Studio and Location

During the last six months, motion picture studios continued to make their sound recording equipment more portable and to bring the talking picture gradually to the same technical perfection as the old silent picture.

Cameras and Accessories

Evident need for a greater standardization exists, particularly with regard to camera silencing. The Radio Corporation of America have announced the perfection of a silent 48-cycle camera motor which eliminates the necessity of gears between the motor and camera. They also announced a 720 r.p.m. silent camera motor for use on Fearless and Bell & Howell cameras.

Safety devices have been introduced which prevent damage to the mechanism of the camera jams. A sound absorbing case covers the entire camera. For studio use, a special metal stand is provided which rides on three rubber tired wheels. The cameraman stands on a small rear platform.

Huguenard and Magnan have designed a camera employing four lenses and taking 12 pictures in an area the size of standard 35 mm. frame. With a linear velocity of the film equal to 3 meters per second, 2,400 pictures may be exposed per second. Pictures made of the free flight of a large fly show that it beats its wings about 100 times per second, whereas a Senegalese linit moves its wings only 30 times in a second.

Studio Illumination

Very few new pieces of illumination equipment were introduced in American studios. An addition to the cast silicon-aluminum equipment announced in the previous report is a new spotlight employing a 2,000-watt, 115-volt monoplane filament lamp.

For general lighting in British studios, banks of lamps are commonly used with as many as 40 lamps in a unit consuming about 10 kw. Matted aluminum reflectors are used for each lamp.

Sound Recording

Maxfield has shown that an empirical relationship exists between the placement of camera and microphone, and the acoustic properties of the set. Some eight or ten pictures have been made using the technic, and the results were so well liked that a more general application of the principles is being made.

For the first time in the making of a sound motion picture, short-wave radio communication was maintained between a ship at sea and the studio lot in Hollywood in the recent filming of the "Corsair," a United Artists picture.

With a new intensity meter, it is possible to measure sound and noise intensities in sound stages and theaters. Levels from 15 to 100 decibels above the hearing threshold may be measured. The instrument is characterized by its compactness and lightness of weight.

A permanent magnet light-valve has been devised recently, in which the bulky electromagnetic field coil used in the previous type has been replaced by permanent pole pieces. The ribbons are clamped permanently in position after the initial spacing and tuning operation. The valve is very compact when used in a studio film recorder.

Satisfactory recording of frequencies up to 10,000 per second is claimed for the Fidelytone system of sound recording developed in England. An image of the cathode consisting of a long metal strip in an exhausted glass tube is formed on the moving film, the light glow extending along the length of the cathode from the metal anode opposite its center point. The length of the glow varies in accordance with the modulated input of the tube.

According to a report from Hollywood, a new dynamic microphone has been introduced which has an essentially flat response from 50 to 10,000 c.p.s. The Metro-Goldwyn-Mayer studio has accomplished an innovation by placing the microphone and associated amplifier in a spherical metal housing. Re-recording has assumed a new significance in connection with the dubbing in of foreign language versions with original American action pictures.

One item on the annual technical report of the A. E. G. for 1930 was a description of a new German re-recording apparatus. Three films may be passed through the device simultaneously and the record made on a fourth film, or on a disk.

Laboratory Equipment and Practice

One of the most recent additions to the list of modern laboratories is the new M-G-M Laboratory in Hollywood. All film is processed on machines, of which there are twelve, and only that actually being handled is exposed as all other film is stored in self-closing steel lockers. The maximum capacity of the laboratory is 300,000 feet of negative and 4 million feet of positive per week. Each developing machine is a distinctly separate unit from

(Concluded on page 22)

W. C. KUNZMANN,
Chairman, Convention Committee,
S.M.P.E.

H. T. COWLING,
Treasurer, S.M.P.E.

EVERYBODY BENEFITS...

. . . by the introduction of Eastman *Super-sensitive* Panchromatic Negative. Actor, director, camera man, laboratory worker, exhibitor, audience . . . right down the line, definite and substantial advantages are derived from this major improvement of 1931. And the producers and exhibitors in whose pictures it is used benefit most of all . . . in better photography, and better pictures in general. Eastman Kodak Company, Rochester, New York. (J. E. Brulatour, Inc., Distributors, New York, Chicago, Hollywood.)

EASTMAN *SUPER-SENSITIVE*
Panchromatic Negative, *Type 2*

all installations

PORTABLE or PERMANENT
SHOULD HAVE FIREPROOF BOOTHS

Both Portable and Permanent Type Projection and Transmitting Booths

STANDARD SIZES

4′	x 6′-3″	x 7′-1½″ high
6′-3″	x 8′	x 7′-1½″ high
8′-3″	x 9′	x 7′-1½″ high
9′-3″	x 12′	x 7′-1½″ high
9′-3″	x 14′	x 7′-1½″ high

BLUE SEAL booths are made of ¼″ thick transite with angle iron 1¼″ x 1¼″ x 3/16″. The panels are interchangeable and bolted together with stove bolts. The seams are filled with transite cement. The floor sheets are ⅜″ thick asbestos.

The Underwriters throughout the country have approved these booths, as well as the fire and building departments of many cities.

Special booths built to conform with the Rules and Regulations of the Steamship Inspection Service on United States Shipping Lines.

Soundproof booths on rollers for microphone announcements from back-stage our latest specialty.

Write for Catalog of Blue Seal Products

BLUE SEAL PRODUCTS CO., INC.

MANUFACTURERS OF MOTION PICTURE ACCESSORIES SINCE 1913

Also Distributor for Johns-Manville Asbestos Products

260 Wyckoff Street Brooklyn, N. Y.

the mixing tank and chemical room at one end to the dryer at the other.

Laboratory processing of negatives and master prints is quite satisfactory but evidence exists that much of this quality is lost in the preparation of release prints, on which the public judges the value of the entertainment of a picture. Recommendations are being drawn up to correct this serious production defect.

Depue of Chicago has announced a 35 mm. combination sound and picture printer, as well as a printer for color picture work. Duplex Motion Picture Industries, of New York, also have introduced a combined picture and sound printer as well as equipment for handling bi-pack negatives.

Standard Kine Laboratories in England have installed apparatus for working the Hepworth "stretched" negative process. Films taken at 16 pictures per second can be "lengthened" and subsequently projected at higher speeds. It is claimed that "slow motion" films can be made by this method from normal negatives.

A new model Bell & Howell splicer for 35 mm. film is equipped with disappearing pilot pins, for splicing 16 mm. film. A heating unit maintains a constant temperature in all parts of the machine with which the film comes in contact.

Projection Equipment and Practice

Unperforated Czaphane film was projected on a Cinelux projector at a meeting of the French Société de Photographie held this summer. Although the facilities did not permit reproduction of the recorded sound, it was reported that the demonstration otherwise, was successful. Framing of the unperforated film was accomplished by projecting light through images of perforations (printed along one side) onto a selenium cell connected to a one tube amplifier. Splicing is accomplished by treating the surface with a normal zinc chloride solution at a temperature of 140°F.

Sound Picture Projection

While there has been some improvement in the quality of reproduced sound in the better type of theater, during the past year there has been no radical improvement in the devices or in the method of reproduction. Very slight improvement, if any, has been noted in the quality of reproduced sound in smaller theaters.

A lamp for slitless sound reproduction has been devised by Dunoyer. Essentially the lamp consists of a cylindrical glass bulb having a flat piece of optical glass sealed in one end exactly parallel with a tungsten filament 25 mm. long and 0.1 mm. diameter. The filament is made in such a way as to be perfectly rectilinear at its normal temperature of 2290°K. The image of the filament falls on a triplet anastigmat lens which at a magnification of 8 gives a scanning zone of 3 mm. length by 0.0125 mm. width.

Projector Light Sources

Data on new projector lenses are very meager for the past six months. At the Congress held in Dresden in August, Joachim presented a comprehensive paper dealing with optical systems for projection.

An effort to meet the demand for a portable source of illumination of greater brilliancy is indicated by the introduction of a new low amperage projector lamp designed to operate on 115 volts a-c. current at a maximum of 15 amperes. A compact portable full-wave rectifier provides direct current for its operation. Automatic trimming is afforded by a differentially wound motor.

Non-intermittent Projection

A non-intermittent projector for very thin (cellophane) film was demonstrated successfully in Madrid, Spain. The film has a row of perforations along one side and the sound track is printed along the other border. Since the film moves continuously, the sound record does not have to be displaced from the picture but runs alongside each picture.

Screens

A new sound screen recently demonstrated in London consists of a special fabric upon which small semi-parabolic lenses ⅜ inch in diameter are mounted with a special light reflecting cement. The spaces between the lenses are cut away. A screen 22 ft. by 17 ft. carries about 460,000 lenses.

In a new type of reverberation meter, sound energy is converted to electrical energy and a series of points are recorded on a waxed paper drum which give graphically the exact history of the sound decay.

Applications of Motion Pictures

Drawing or free-hand sketching from motion picture films is becoming more and more an accepted practice in art schools. Commercial classroom films are now available for this work.

Television Systems

Short has published details on a television direct pickup camera, in which the image of the person being televised is focused directly upon spiral number one of the scanning disc. The camera is mounted on a rubber-tired truck which runs under its own power. Detailed movement of baseball games, tennis matches, and airplanes in flight have been followed easily with the apparatus, and it is possible to move quickly from a "close-up" to a "long-shot."

At the end of each scanning cycle in the Barthélemy system, the beam is interrupted a very short time. These lapses produce a 480-cycle frequency which filtered by an ingenious amplifying circuit, is used to operate a synchronous motor which drives the receiving scanning disc. A 3-watt neon lamp is used for a picture area of 600 sq. cm.

General Recording

Stroboscopic motion pictures of the angular transients of synchronous motors have been taken by Edgerton with the aid of a mercury arc thyratron. Possible applications are the study of the claw mechanisms of high speed cameras and projectors or the valve spring action of gas engines.

Color Cinematography

A new additive screen process of three-color cinematography was demonstrated successfully before the Royal Photographic Society in May 1931. The manufacture of the film has been described by Periera, who states that 1000 foot lengths of aceto-cellulose nearly 2 feet wide, are ruled with a three-color screen so that about a half million squares cover each 35 mm. frame. A coating of collodion stained green is put on the base and a greasy ink resist applied to the surface by means of an engraved steel roller. A bleaching bath then destroys the green dye where it is not protected. A red line screen, and finally a blue screen are next coated in an analogous way, as the first screen. A special panchromatic emulsion of large sized grains is used as the last coating, so that on reversal of the negative, a fine-grained positive is said to be obtained. A projection method of making duplicates is said to have been perfected.

Films and Film Processing

The high speed "pan" films which the professional cameraman has had since the first of the year, have now been made available to the amateur. Besides the American-made product a German-made 16 mm. panchromatic reversal film of very high red sensitivity has also been announced.

Examples of a lenticulated film process called Agfacolor were projected for the first time publicly before the session of the Congress held in Dresden in August.

Statistics

According to data published there has been a 50 per cent increase in the number of European theaters since 1926. As of the end of the year 1930, there were 33,842 theaters compared with 22,425 in 1926. The seating capacity has increased 48 per cent; the present theaters seating about 1⅓ million persons. There are now 72 theaters for each million inhabitants.

Differences in language cause quite wide variation in the length of a sound film. Five films made of the same picture by an American producer had the following lengths: English 8,010 feet; Spanish and Italian 8,259; French 8,516; and German 9,609 feet.

▲

POWERFUL SOUND SYSTEM

A powerful, but compact, sound amplifying system was installed recently at the Lafayette swimming pool, at Long Beach, Long Island, N. Y.

Through the use of carefully selected, highly efficient apparatus, it has been found possible to reduce the amount of required equipment to a new minimum, and still obtain satisfactory results.

The swimming pool is set back about 75 feet from the boardwalk and occupies a space 125 feet long by 60 feet wide. At one end of the pool, there is a five-story building. The loudspeaker is placed on the roof of this building, facing the pool. A dynamic reproducer is used, in conjunction with a No. 9 horn. The distance range of this combination is so great that both voice and music are clearly audible, not only from all parts of the pool, but also on the boardwalk and for a considerable distance along the beach on the other side of the boardwalk.

The amplifier, which is located in a small control booth, alongside the swimming pool, consists of an Electrad D-250 direct-coupled unit. This uses a 124 tube in the first stage, a 145 in the second and two 150's in push-pull in the output stage. Two 181 half-wave rectifiers are employed. The amplifier is mounted in a cabinet, which also contains a special radio tuner, a Hardray automatic record changer and electric phonograph, and also the necessary control switches and meters.

One of the features of this installation, is the utilization of a Universal microphone for making announcements, paging employees and visitors, conducting swimming races, instructing novices in swimming, etc.

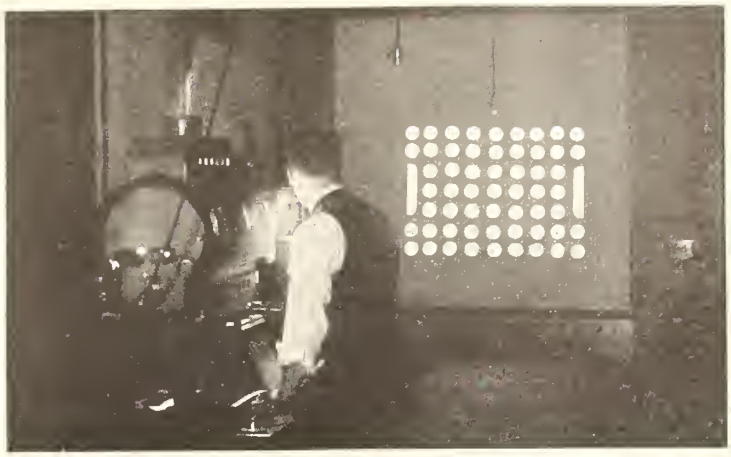
▲

INCREASING AMPERAGE

A trend from projection lamps of lower amperage to those of higher amperage is reported by the Ashcraft Automatic Arc Company, basing its observations on the trend in its own sales.

Among them were a high intensity lamp to Paramount Publix, another to Continental Theatre Accessories, while two Ashcraft C-70's (high intensity reflectors) were ordered by the Western Theatrical Equipment Company. An order from National Theatre Supply Company specified two air-blast high-low models.

New Projection Efficiency



SUPER CINEPHORS are true anastigmats. They improve the image quality by overcoming astigmatism, spherical aberration and chromatic aberration. Pictures projected with Super Cinephors have maximum sharpness of detail, contrast between blacks and whites and brilliance of illumination.

50% more light is concentrated on the film by the new B & L Condensing System. This overcomes loss of light due to reduction of reflecting area of perforated screens. For finest projection use this condensing system with Super Cinephors.

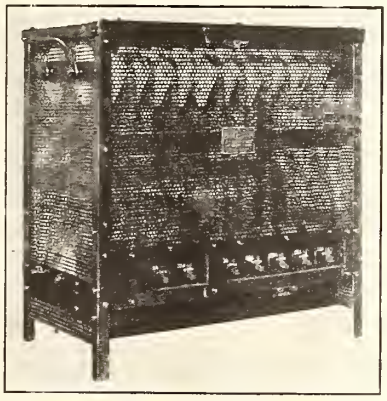
Catalog E-16 describes them and gives valuable information to the projectionist. Send for your copy now.

BAUSCH & LOMB

681 St. Paul St. Rochester, N. Y.

HOFFMANN-SOONS say

"There Is No Substitute For RELIABILITY"



THE ONLY UNION MADE RHEOSTAT

Making claims is one thing—Making good is another!

Projectionists and theatre owners who have installed Perfection Rheostats KNOW our guarantee means the best results—clearer pictures—longer life.

Now equipped with solderless, adjustable lugs to take wire sizes from No. 4 to 4/0 without any additional cost.

SOLD BY ALL BRANCHES OF THE NATIONAL THEATRE SUPPLY CO., SAM KAPLAN, NEW YORK, AND BY YOUR DEALER.

HOFFMANN-SOONS

Electrical and Engineering Corp., 387 First Avenue, New York City

PERFECTION **RHEOSTATS**

New Developments and News of the Industry

PHONOGRAPH PICKUP WITH AMPLIFIER FOR LARGE VOLUME

The Sangamo Electric Company, Springfield, Ill., manufactures a high-grade line of audio transformers for public address and auditorium sound systems.

The outfit for use in public halls and auditoriums was designed to give large volume and high quality of tone. The company does not build the complete unit, but is in a position to furnish such parts as audio transformers, impedances and condensers. When equipped with an auditorium type of speaker which will handle the volume output, this amplifier and power supply will give exceptionally high-grade results. Volume sufficient for a large auditorium can be had with ease and without any 60-cycle hum.

▲

INTERNATIONAL PROJECTOR CORPORATION BUSY

International Projector Corporation has placed its full factory staff on a 54-hour week basis in addition to running three nights a week overtime, according to an announcement made by Herbert Griffin, general sales manager of that corporation.

The increased production and overtime work follows on the addition of three new items to the line, the Acme Portable Sound and Motion Picture Projector, the Pockette 16 mm. Camera, and the Casette 16 mm. Projector. International Projector Corporation has made no reductions in its factory staff since 1929 and the overtime was necessitated by advance orders for the new products.

The corporation also manufactures the Simplex Projector equipment for use in motion picture theatres.

▲

BELL & HOWELL APPOINTS SALES MANAGER

J. G. Llewellyn, for the past two and a half years assistant sales manager of the Bell & Howell Company, Chicago, has been advanced to the position of sales manager. Mr. Llewellyn has been acting sales manager for the past year.

▲

SOLID GOLD CONTACTS NOW USED IN MODERN MICROPHONES

The microphone, from the very nature of its use and construction, is a delicate piece of apparatus. It must be handled carefully and used only according to the manufacturers' directions.

It has been found that ordinary microphones are subject to a certain type of deterioration, regardless of care, and, in fact, whether in use or on the dealer's shelf. This deterioration is caused by moisture in the atmosphere, which corrodes nearly all metals. In the case of the microphone, the surface of the metal diaphragm corrodes, ruining the contact with the carbon.

To remedy this condition, gold plating was tried. It was then discovered that since the gold was porous, corrosion still took place. The Universal Microphone Co., Ltd., finally solved the problem through a patented process by which a 24-carat sheet of pure gold is stamped on to the surface of a duralumin diaphragm. Using this method, the gold is no longer porous and hence, moisture can no longer affect the diaphragm. Moreover, the gold does not flake nor come off the duralumin, even after extended use.

▲

INDOOR PHOTO LIGHT

The amateur as well as the professional photographer can now obtain wonderful indoor photographs and movies with any camera, by using the new "Photo-Sun" Lamps manufactured by the Blue Seal Products Company, Incorporated, 264 Wyckoff Street, Brooklyn, New York.

These lamps are miniature arc lamps,

operating on either a-c. or d-c., and furnish brilliant light continuously from fifteen to twenty minutes, as required, and are being marketed in two sizes, model No. 395 at 8 amps. which lists at $3.95 complete and model No. 500, a slightly larger lamp, operating at 12 amps. which lists at $5.00 complete.

The cost per picture with an ordinary camera amounts to 1/30 of a cent for carbon and current consumption.

▲

COPPER OXIDE RECTIFIER INTRODUCED FOR MOTION PICTURE SERVICE

The first copper-oxide rectifier to be introduced for the motion picture field, built to improve the growing use of full vision screens, wider films and colored motion pictures has been announced by the General Electric Company.

The rapid strides made in the motion picture industry have required radical changes in theatre equipment. The so-called "low-intensity" projectors installed in most motion picture theatres are not entirely suitable for the present colored projection and greater screen areas. As a result, a rectifier of high intensity and capable of meeting these requirements was needed.

One of the outstanding features of the new rectifier is that it may be used either for a high-intensity projector or for one or two low-intensity projectors. Used with a high-intensity projector, it supplies 60 to 70 amperes of arc current. Operated with one or two low-intensity projectors, each of the two sections supplies 30 to 35 amperes.

The new rectifier makes use of the copper-oxide disc principle of rectification, which gives it durability, long life and freedom from maintenance expense. A system of forced ventilation, using radiating fans and two small electric blowers, forces a steady stream of cool air over the copper-oxide elements and maintains a temperature within eight degrees of the surrounding air temperature. Not until such a cooling system was perfected was it possible to develop a successful high output rectifier.

No objectionable noise is made by the rectifier, which enables it to be placed in the projection room. Installation and operation of the unit are simple. One switch starts or stops the rectifier instantly, without the usual "starting" or "warming up" period.

▲

NEW OPERADIO SPEAKER

A new extremely small dynamic speaker for use with very small midget sets has just been added to the line of speakers built by the Operadio Manufacturing Company of St. Charles, Illinois.

Though it is but 6 inches in diameter and 3⅜ inches overall including the speaker transformer, it has an excellent response curve, high efficiency, and is capable of handling exceptional volume for a unit of these physical dimensions.

Operadio patented inverted construction that places the field coil within the conical diaphragm allows excellent structure of the magnetic path and the use of a larger field coil than customary in small speakers of ordinary design.

▲

TYPE 2-AC X-CELLS

The new type 2-AC X-Cell, manufactured by the Pacific Research Laboratories, 1907 4th Avenue, Los Angeles, Cal., is designed for the purpose of eliminating all batteries connected with the operation of motion picture sound-on-film apparatus. Owing to the nature of this type of cell it is possible to employ raw a. c. on the filament of the exciter lamp without the use of filters or additional apparatus of any kind. This means a great saving in the cost of equipment and maintenance and at the same time simplifies the operation to a remarkable degree.

ANNOUNCING *THE NEW*

WESTON PHOTRONIC CELL

In use and construction, the Weston PHOTRONIC CELL is different—utterly simple—and low in cost.

Revolutionizing in operation, amazing in performance, the PHOTRONIC CELL reduces light sensitive cell applications to a new simplicity. Reliability increased . . . new fields opened . . . present developments advanced. The PHOTRONIC CELL sets an entirely new standard of performance. *Write for Circular YY.*

OUTSTANDING FEATURES

- Highly sensitive.
- High current output (approx. 5 milliamperes in direct sunlight—one microampere per foot-candle).
- Operates relays directly.
- Unlimited life.
- No drifting.
- No deterioration.
- No batteries.
- No dark current.
- No readjustments of circuit.
- Non-microphonic.
- Withstands direct sunlight.
- Not easily damaged.
- Nothing to replace.
- Low in cost.

WESTON

ELECTRICAL INSTRUMENT CORP.

608 FRELINGHUYSEN AVENUE . . . NEWARK, N. J.

Outstanding Values

ARE AVAILABLE TO THE INDUSTRY IN

CANADY RECORDING EQUIPMENT

Here is the last word in quality and actual performance at a price you can afford. Model S was specially designed for real light weight portability. It is a marvel of simplicity and efficiency. We had the camera man in mind when we built it. Hence we say—you can afford it.

CANADY RECORDING TUBES

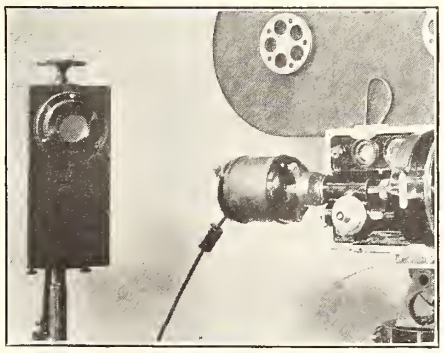
are the latest and most sensational development in the recording industry—unique and startling in design, this new tube is conservatively estimated to expose from 400,000 to 500,000 feet of positive film with a pronounced extra gain of light heretofore impossible and producing quality of sound far beyond present possibilities.

CANADY RECORDERS

Equipped with double filter of advanced design, eliminating "wows and flutter." Extra heavy shafts, hardened and ground—running in bronze and ball bearings. All gears and moving parts enclosed. Lamp holder with micrometer adjustments. Entire mechanism last word in precision workmanship.

Specially Built Condenser Microphones For Recording Purposes

COMPLETE OR PARTIAL EQUIPMENT FURNISHED FOR ALL PURPOSES.



CANADY SOUND SYSTEMS HAVE WON IMMEDIATE RECOGNITION FOR GENUINE QUALITY THROUGHOUT THE WORLD

CANADY RECORDING EQUIPMENT COMPANY

714 Leader Bldg. Cleveland, Ohio

DEBRIE DEVICE PRINTS SOUND AND IMAGE AT SAME TIME

Andre Debrie, Inc., French motion picture equipment company of 30 years' standing, manufacturing studio and laboratory apparatus, including a machine for printing image and sound simultaneously, a device which several companies here have been trying to obtain, has established American headquarters at 551 Fifth Ave., New York.

One of the important features of the Debrie equipment is a new studio camera for taking sound pictures, with the following improvements:

1,000 feet inside magazine, new model of rewind and take up, anti-buckling device with electric control, indication of sound track in printing and focussing apertures, simplified automatic dissolve, without lock, automatic safety cut out in case of faulty operation, aperture plates 18.2 x 24.5 with removable mask reducing to 18.2 x 22.

The laboratory printing machine which prints simultaneously image and sound in normal and reverse sense at the rate of 3,000 feet per hour claims a special feature in that any amount of changes of light can be obtained by a simple process of a specially perforated control band which commands the light changes.

Debrie also has apparatus for taking large films, 65 to 72 mm.

Other items include a special high speed camera with 2,000 feet magazine to take pictures at the rate of 240 frames per second, and Debrie's polishing machine which takes out scratches on the old negatives and polishes at the same time.

Basil Lermont is manager of the New York office.

▲

KLIEGL ISSUES NEW CATALOG

Kliegl Bros. of New York, manufacturers of lighting specialties, have announced the publication of a completely revised catalogue, with list prices adjusted to present-day levels, and with the very latest improvements and new devices for theatrical, decorative, and spectacular lighting, included in its pages—such as footlights, borderlights, spotlights, floodlights, and numerous other forms of lighting equipment and apparatus. The publication is complete in every respect, fully illustrated, thoroughly indexed and conveniently arranged for quick reference. This new Kliegl Catalog A is available to any one interested in lighting. Copies may be obtained, free of charge, by a request addressed to Kliegl Bros., 321 West 50th Street, New York, N. Y.

▲

ELECTRO-ACOUSTIC SOUND SYSTEM—TYPE EAP-12

The Electro-Acoustic Products Co., 200 E. Illinois Street, Chicago, introduces a new amplifier having many new and distinctive merits. This unit, catalogued as the EAP-12, is of the semi-portable type—a four-stage resistance coupled amplifier self-contained in a single unit requiring no preliminary amplification or input transformers for operating from carbon or condenser microphone or phonograph or radio reception. All input and output connections terminate in receptacles at the back of the amplifier. This makes the matter of installing equipment very simple.

The amplifier utilizes in the output stage two type 250 tubes in push-pull and will deliver at least 12 watts of undistorted power. A variable output impedance switch is provided so that impedances as low as 8 ohms and as high as 3,000 ohms may be quickly matched, making it possible to use any type of speaker or a number of speakers in parallel.

The amplifier has a gain of 6 d.b. with frequency characteristic practically flat to 9,000 cycles. A similar amplifier type EAP-12 PC is available with a gain as high as 95 d.b. for operation directly out of a photoelectric cell.

This unit is particularly useful for operation in connection with mobile equipment such as automobile installations for advertising purposes.

▲

ANNOUNCES VERTICAL WOOL-PACKED BEARING MOTOR

Bodine Electric Company, 2264 W. Ohio St., Chicago, Illinois, announces that, due to the construction of the end brackets of the new Type N-5 motor, they may be provided in vertical or flange mounted models to meet any specified requirement. Umbrella covers are optional on these installations.

These motors are available in ratings of 1/10 and ⅛ h. p. at 1725 r.p.m. and 1/20 and 1/12 h. p. at 1125 r.p.m.

▲

300 WATT "NO RESISTANCE" LAMPS FOR VICTOR

Victor Animatograph Corporation, Davenport, Iowa, announces that a new G-E Mazda projection lamp of 300 watts rating, which does not require any form of lamp resistance, is now available for use in all Model 3 and 5 Victor projectors and animatophones.

The lamp may be obtained in voltages of 105, 110 and 115.

Initial tests indicate that this new 300-watt lamp may closely approach in intensity of illumination some of the highly efficient low-voltage lamps which employ rheostats or transformers to reduce the line voltage to that of the lamp rating.

This new 300-watt lamp is of the regular 16 mm. T-10 size and is equipped with the bayonet type prefocussed base.

▲

EARL CARROLL'S "VANITIES" ADOPT P-A. SYSTEM

Earl Carroll's "Vanities" have adopted the Western Electric public-address system for sound amplification and in doing so they are presenting to the public, for the first time, innovations that promise to revolutionize legitimate stage producing.

At the new 3,000 seat Earl Carroll Theatre, the largest house in the country for legitimate stage productions exclusively, a complete system of loudspeakers was installed for the opening of the new "vanities" on August 27. Six loudspeakers were installed in the auditorium itself and 20 in other parts of the building.

Among the features possible because of this innovation in the auditorium itself are:

1. A general reinforcement of music and voice from the stage;

2. A disappearing orchestra working on an elevator platform so that after the orchestra has descended to the basement, the platform can be replaced and used for the stage production while the orchestra's music is still audible to the audience;

3. Provision for individual features involving a specially constructed microphone arrangement, including a microphone that can be raised from alongside the footlights through a push spring operated by one of the actors on the stage. This microphone system permits various combinations of musical effects on and off stage;

4. The use of special records to reproduce off stage sound effects.

In addition to loudspeakers in the auditorium itself, others, in dressing rooms and in the lobby will help evolve a general efficiency system.

In the lobby the loudspeaker makes possible the curtain announcement for the beginning of each act.

The loudspeakers in the dressing rooms will enable members of the cast to hear a continuous reproduction of the performance on the stage and will make it possible for the stage manager sitting in the wings to keep the players in their dressing rooms advised of the play's progress and of their cues, eliminating the call boy's nightly rounds.

The public-address system installation at the theatre was made by Electrical Research Products represented by J. J. Way, public-address system specialist and by I. F. Durst who supervised the work of installation.

▲

SPECIAL IMPEDANCE MATCHING TRANSFORMERS

Ferranti, Inc., 130 West 42nd St., New York, have developed a special impedance matching transformer which is able to transmit frequencies from 30 to 8000 cycles with less than ½ of 1 db. drop. This is obtained by the special type of construction used in the manufacture of these transformers which reduces the leakage reactance, self and mutual capacities to a minimum.

These transformers are particularly suited for the exacting requirements of broadcast stations, sound studios, transmission engineering as well as special public-address systems and vacuum tube engineers. A few of the uses of this special impedance matching transformer are microphone mixing, microphone to line, tube to line, line to line, line to speaker, tube to speaker and tube to line. Many other special uses are found for this transformer which is wound to the customer's own specifications.

In addition to these special units they still continue to manufacture their standard audio and output transformers which also give a particularly flat curve with a maximum transfer of energy over the entire broadcast range.

Literature will be sent on request.

▲

A NEW GENERATOR

Motor generators for replacing storage batteries in theatres have been developed by the Electric Specialty Company of Stamford, Conn. These machines supply low voltage direct current for the fields of loudspeakers and for the exciter lamps of the sound equipment.

A simple filter system is used to supply power to the exciter lamps, but filters are not used with the horn fields. The machines are furnished complete with filters, when required, and they may be connected in place of the storage batteries.

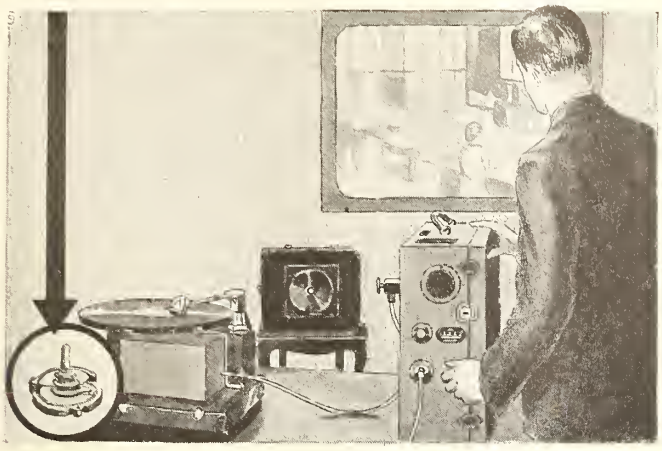
▲

CANADY RECORDER

Word comes from Don Canady that his company now has concluded all tests in perfecting a 16 mm. sound-on-film recorder.

As the Canady Recording Co. now markets a complete line of 35 mm. recording equipment, together with recording lamps for sound-on-film, it is interesting to know that with the addition of the 16 mm. apparatus, no detail has been overlooked.

Mr. Canady, well known in engineering circles, together with M. O. Mattlin, also an engineer of prominence, spent several weeks in New York recently demonstrating the Canady line to members of the trade. A favorable impression was created in the minds of all who saw and heard the results of the Canady recorder.



HOME, PORTABLE OR THEATER

TALKIE PROJECTORS

give finest results with

CLAROSTAT CONTROLS

Speed Controls

Clarostat Compression type Rheostat gives micrometric control of speed. Has been adopted as standard equipment by some of the largest manufacturers of portable projectors.

Made in various resistance ranges from 10 ohms up to 10 megohms, and in five sizes up to 250 watts.

Volume Controls

Clarostat Volume Controls are absolutely quiet, long lived units, with special alloy contactor and windings to avoid thermal e.m.f. Made in simple potentiometer or dual and triple units for constant impedance work to meet exacting needs of sound industry. Insulated or grounded shaft and bushing, as desired.

New model Graphite Element Potentiometers for use where extra high resistances are required. These have the revolutionary Geared Roller Contact for long life and silent operation.

Clarostat Mfg. Co., Inc.

285 N. 6th Street, Brooklyn, N. Y.

CLAROSTAT

It's better *to use* Electro-Acoustic *Sound Systems*

True definition of tone is actually achieved in Electro-Acoustic Amplifiers through a scientifically designed resistance coupled circuit employing the highest standards of material and workmanship.

Perfectly designed, electrically and mechanically, control is easily and simply maintained. Little or no experience is required to operate them.

Durability is another outstanding feature. A few models are entirely portable or especially designed for use in moving vehicles. All are built with large safety factors to withstand unusual mechanical and electrical strains.

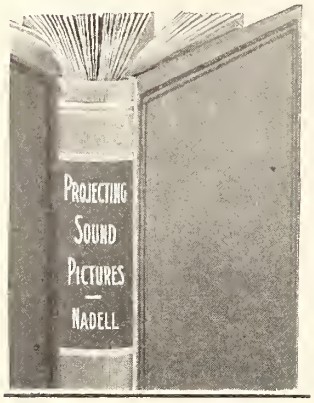
A complete line of power amplifiers with output from 2 to 500 watts . . . . .

There is an Electro-Acoustic System designed for your particular use whether it be for Public Address, Studio Recording, "Nemo" Amplifiers, Broadcast Studios, or Audible Advertising.

ELECTRO-ACOUSTIC PRODUCTS COMPANY

200 E. Illinois Street Chicago, Illinois

sound motion picture equipment



—how to operate it —how to repair it

This new book makes easy the successful operation and repair of all makes of sound projection apparatus, by explaining simply and clearly the fundamentals of sound reproduction and projection upon which all types of equipment are based.

— Just published —

PROJECTING SOUND PICTURES

By AARON NADELL

Publix Theatre Corporation; Formerly of Electrical Research Products, Inc.

265 pages, 6 x 9, 100 illustrations, $2.50

Whether you are a sound projectionist by profession or only occasionally work on sound equipment, you will find this an invaluable handbook, presenting the fundamentals that will enable you to understand the problems arising in the operation and repair of all makes of sound equipment.

NOTE: Questions, with answers, at the end of each chapter, a Precaution Index, and a Trouble Index, form the equal of an invaluable "trouble-shooting" chart; a quick means of looking up the cause and cure of every projection trouble.

Beside explaining the theory of sound reproduction on disc and film, the book takes up each unit of the sound equipment, explaining the underlying theory and principles, showing by description and illustration how these are applied in various types of apparatus.

At the same time the author points out the common troubles associated with each unit and the remedies for them. In addition a chapter is devoted to precautions to take to prevent trouble and another on tracing trouble and correcting it.

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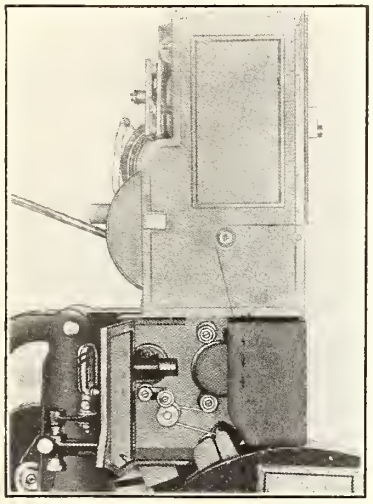

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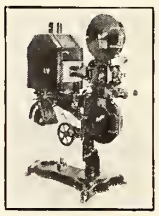

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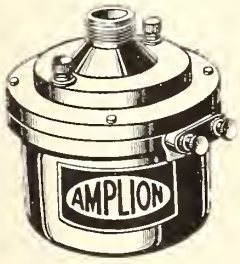
AMPLION OCTOPHASE SPEAKERS



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In this unit, the area over a scientifically domed diaphragm encased in a scientifically shaped air chamber, is divided into eight divisions. The centers of gravity of each of these divisions are exactly equi-distant from the throat of the unit and since all operate under identical pressures, the sound impulses from each division reach the throat of the horn in perfectly timed synchronism with the arrival of sound impulses from all the other divisions. From these eight divisions, this producer derives its name OCTOPHASE.

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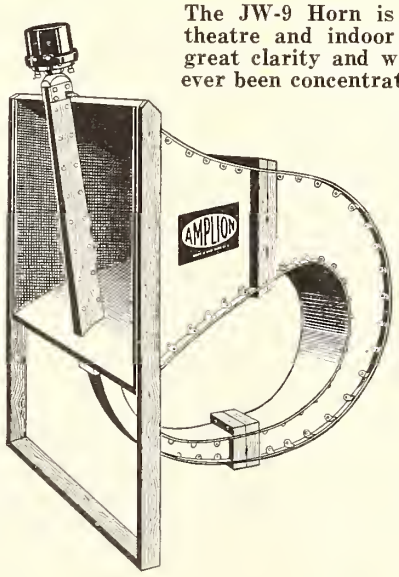

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Air Column 108"
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REPAIR—REPLACE NEWS

VOL. I, NO. I OCTOBER, 1931

REPLACE WITH SIMPLEX PROJECTORS

Neglect Is Poor Economy

"It is an excellent thing that theatre owners are coming to the greater realization of the importance of good projection. In the past there has been too great a tendency to believe that all expenditures for the proper maintenance of equipment and the betterment of projection were a waste of time and money. Good projection can only be secured by having good men, good working conditions and standard equipment kept in first class condition at all times. Projection rooms are under weekly supervision by inspectors of the Department, but will not compel repairs and replacements unless it is necessary to do so. NEGLECT, HOWEVER, IS VERY POOR ECONOMY AND THEATRE OWNERS AND MANAGERS SHOULD NOT WAIT UNTIL THEY ARE COMPELLED TO MAKE REPAIRS. Equipment kept in the right condition insures the safety of audiences, adds to their pleasure, reduces damages to film and I sincerely believe increases box office receipts."

BART F. GREENE
Chief Inspector of the Bureau of Gas & Electricity, City of New York

The Effect of Motion Pictures on the Eyes

(Presented before the Society of Motion Picture Engineers.)

Under favorable conditions moving pictures do not cause serious eye fatigue, but it must be borne in mind that several very important elements are necessary to make these "favorable conditions."

If the eyes of the observer are normal for distance vision or corrected for refractive defects the owner should not experience discomfort in viewing motion pictures provided certain other conditions prevail.

PROPER PROJECTION IS AN IMPORTANT FACTOR IN THE ELIMINATION OF EYESTRAIN AND EYE DISCOMFORTS and here again great improvements have been made in the mechanical field.

Any unsteadiness or jerkiness will produce eyestrain as a result of the abnormal burden placed upon the extrinsic muscles of the eye in their effort to keep the eyes in alignment with uncertain and erratic movements of the pictures on the screen.

GUY A. HENRY
General-Director of the Eyesight Conservation Council of America

The Economy of Good Equipment

We wonder how many readers of our department took note of Harold B. Franklin's article in the *Showman*, published in the *Motion Picture News* of May 5. I have always been a great admirer of Mr. Franklin's methods, and in looking over his article find many valuable pointers that intelligent managers everywhere ought to take note of.

Let me quote one sentence, in which he says, "It is not necessary for a manager to be able to understand the details of projection, but the successful manager should be able to distinguish good from bad projection, and THE PROGRESSIVE MANAGER KEEPS ABREAST WITH THE IMPROVEMENTS THAT ARE BROUGHT FORTH IN THE FIELD."

Which leads us up to the subject of projection. We were very much surprised to find in our travels that this very important item in theatre operation has been sadly neglected in many of the smaller towns. We happened upon a theatre in a town about twenty thousand population, and the theatre appeared to be quite modern and up-to-date, with the exception of the picture on the screen. And when we reached the booth, we found equipment so ancient, as booth equipment is judged today, that it would look far better reposing in a museum. The projectors were of a very old model, the lamps were the old type arc, and the generator was a big affair that belonged in the same museum with the rest of the equipment.

Without treading on the manager's toes (and he, by the way, was one of the owners of the theatre), we tried to show him what a mistake he was making, both from the standpoint of good projection and economy in operation.

At this time it is not our intention to take upon ourselves the recommendation of any particular type of equipment for the booth as we are selling nothing but ideas, but we do know that NEW EQUIPMENT WOULD HAVE PAID FOR ITSELF IN THIS THEATRE IN JUST ABOUT A YEAR, NOT TAKING INTO CONSIDERATION THE MARVELOUS IMPROVEMENT IN THE PROJECTION.

Managers Round Table Club
CHARLES E. LEWIS

REPAIR WITH GENUINE SIMPLEX PARTS

Poor Projection Means Poor Business

GOOD PROJECTION REQUIRES GOOD PROJECTORS. Poor screen results will do more to injure a theatre's reputation and patronage than any other single factor. Bad projection and good business are never companions. Show me a theatre where proper projection standards are not maintained, and I shall show you a theatre where business is in the same category as its projection.

WILLIAM F. CANAVAN
International President, I.A.T.S.E. & M.P.M.O.

Fire Prevention

In the afternoon session, after reports of officers, Fire Marshall of Canada, Grove Smith, gave a fine address which was warmly applauded. He pointed out the excellent record of fire prevention in Canada and stated that a majority of the modern theatres were fire proof. HE LIKEWISE ADVISED THAT NO OLD PROJECTION MACHINES SHOULD BE USED.

"Exhibitors Daily Review," Thursday, Oct. 18, 1928

Simplex
The International Projector

INTERNATIONAL PROJECTOR CORPORATION

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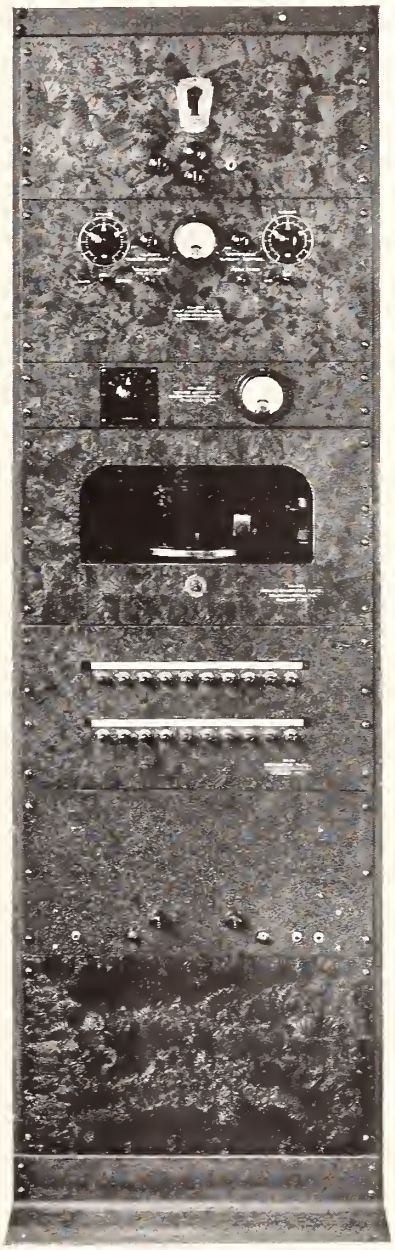
S-M High Quality—Lowest Prices

Silver-Marshall now offers a complete line of the highest quality PA equipment covering new achievements in the field of sound engineering. Based on the time-proven utility, economy and serviceability of rack-and-panel equipment, S-M presents a number of flexible, high-quality units, many of them available for the first time at a popular price. These unit panels may be assembled into a complete sound system for any desired type of service from centralized distribution for schools, hotels and similar institutions, to the more general type of installation for coverage of large indoor and outdoor audiences. It is possible to start out with a few units and expand the system from time to time at a minimum of cost. Added advantages of this type of equipment are accessibility for changes and maintenance, convenience in operation and small floor space requirements. Power outputs from 15 to 100 watts or more may be utilized. Input equipment for voice, radio and record reproduction is available, together with several extremely flexible input control panels, thus allowing wide variety in the mode of operation of the system.

A typical school rack is illustrated with panels, from top to bottom, described below.



PA-72A SUPERHETERODYNE TUNER PANEL

A six-tube Super with power supply, uses 3-'51 vario-mu tubes, has eleven tuned circuits, gives better than 10kc selectivity. Includes jack for monitoring speaker or phones. Output impedance 200 ohms.

PA-53B INPUT CONTROL PANEL

Has control for microphone, radio, and record pick-up inputs, with one-stage amplifier for microphone, allows super-imposing of microphone on either radio or record pick-up. Incorporates meter for adjusting filament on amplifier tube or current on microphone. Input impedances all 200 ohms. Also available for 19-inch relay racks.

PA-60B VOLUME INDICATOR PANEL

A precision power-level indicating-instrument, with rectifier-type meter calibrated directly in db (range—8 to +48 db), is invaluable for maintaining correct levels in centralized systems, indicating overload, etc. Also available for 19-inch relay racks.

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PA-81A DISTRIBUTING PANEL

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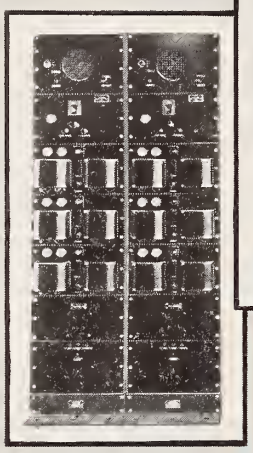

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Sound-On-Film Amplifier. Complete from P. E. cell to Speaker. All alternating current operation.

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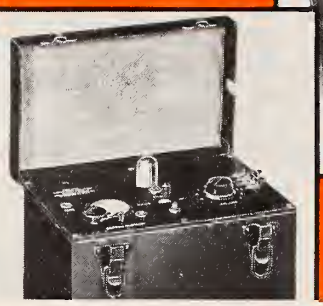

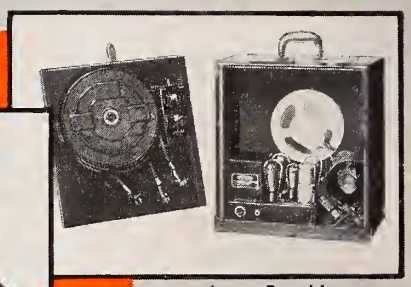

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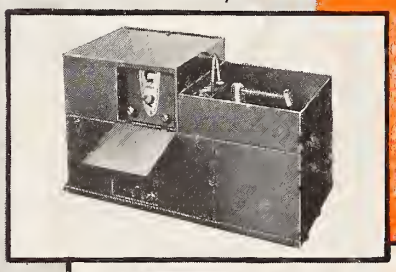
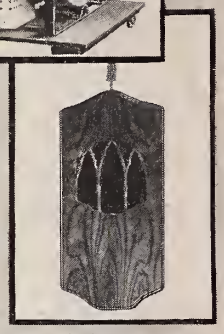
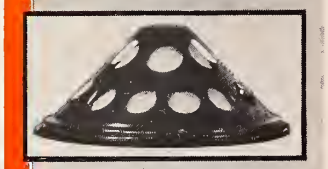
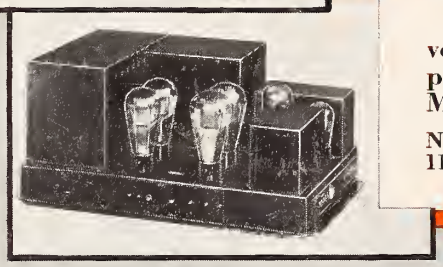




Jack Horner Wall Speaker



Speaker Chassis



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STALLATION OF "SOUND" IN GREAT BRITAIN
By Bernard Brown

Photo courtesy General Electric Co.

Earl Carroll describes operation of auxiliary switchboard located back stage—Earl Carroll Theatre, New York.

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DECEMBER, 193

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FREQUENCY CHARACTERISTIC—Flat from 50 to 10,000 cycles.

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INPUT IMPEDANCE—Caesium type photo-cells.

OUTPUT IMPEDANCE—4000 ohms or three 15 ohm lines.

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EXCITER LAMP CURRENT SUPPLY—10 volts at 8 amperes D.C.

P. E. CELL VOLTAGE SUPPLY—90 volts D.C.

POWER SUPPLY REQUIRED—110 A.C. 50-60 cycles.

POWER CONSUMPTION—300 Watts.

CONTROL APPARATUS—Fader, volume-control, rheostat and meter.

OVERALL SIZE OF CABINET—20" x 16" x 9".

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(FOR 500 SEATS)

GAIN AT 1000 CYCLES—85 DB.

FREQUENCY CHARACTERISTIC—Flat from 50 to 10,000 cycles.

TUBES REQUIRED—1-224, 1-227, 2-247, 1-280.

UNDISTORTED POWER OUTPUT—7 Watts.

INPUT IMPEDANCE—Caesium type photo-cells.

OUTPUT IMPEDANCE—4000 ohms or three 15 ohm lines.

FADING SYSTEM—Exciter lamp changeover.

P. E. CELL VOLTAGE SUPPLY—90 volts D.C.

EXCITER LAMP CURRENT SUPPLY—10 volts at 8 amperes.

POWER SUPPLY REQUIRED—110 volts A.C. 50-60 cycles.

POWER CONSUMPTION—200 Watts.

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OVERALL SIZE OF CABINET—17" x 15" x 8".

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(A Radio Corporation of America Subsidiary)
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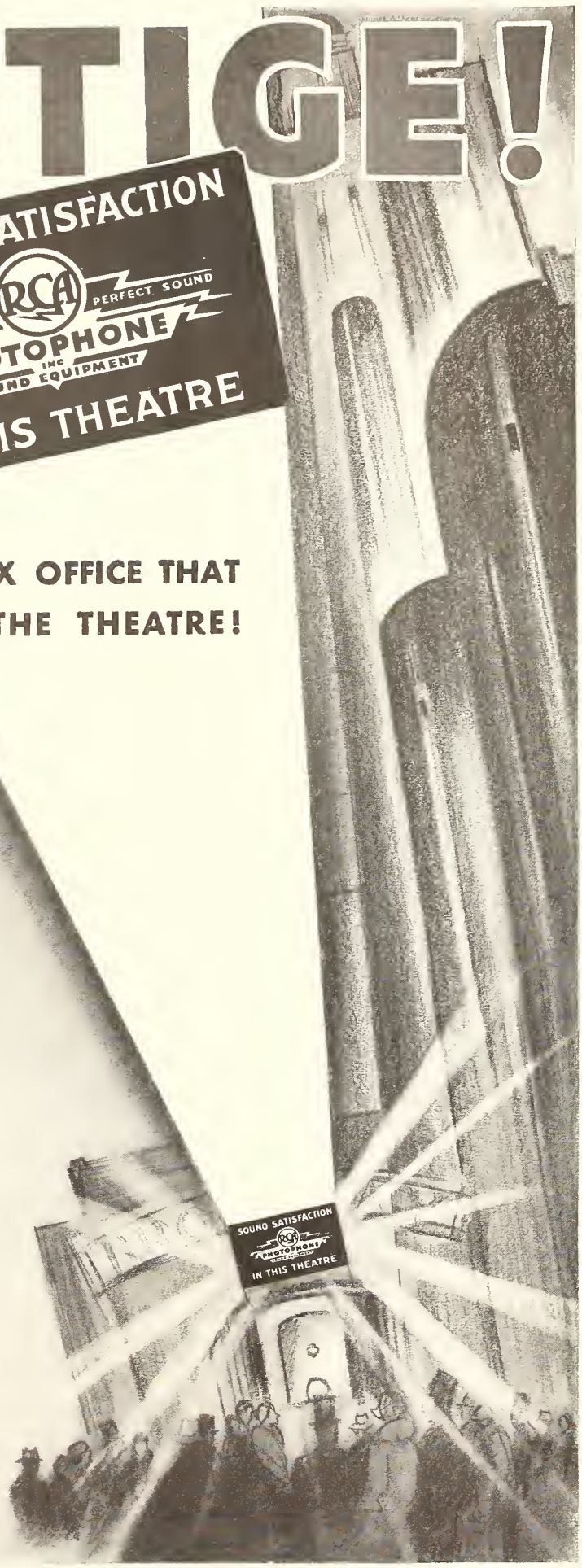


Editorial

DECEMBER, 1931

THE ONWARD MARCH OF PUBLIC ADDRESS

OUT of joint with the downward tendency of the industries, incidental to the prevailing economic depression, is the steady advance in the number of installations of public address equipment.

In times when most of the industries are thriving there is no difficulty in inducing manufacturers and installation engineers to broadcast word of their successes and of the satisfactory state of their operations, but when the general industrial curve dips below normal, and when the daily press finds "depression" and "unemployment" to be profitable front page subjects, there appears to be a tendency on the part of those who are doing well to say little about it.

This may in part be due to a desire not to spur competitors to activity—like the boy in the berry patch who labors industriously and quietly when he is in where berries are plentiful.

It is probably true that during the past year more money has been spent for extensive public address systems, and for smaller installations, than in all previous years, and the movement continues. Perfected public address equipment now available supplies a remedy for structural defects in hotels, auditoriums, churches, halls, factories, schools, etc., which in the past have robbed these interiors of the full benefits of communication and sound transmission.

It is hoped that soon descriptions may be given of the more important of these installations. One installation now under way employs an elaborate central switching system controlling sixty microphones. Information in hand indicates that many other installations of greater or less magnitude are in progress.

Perhaps the electric arts will again serve to start the upward swing of the business pendulum.

▲

VAUDEVILLE ADDED

IN THE wave of unemployment relief entertainment now sweeping across the country, it appears that in the average community the charge for attending a moving picture show may be raised from thirty-five cents to fifty cents if from three to five vaudeville acts are added to the picture bill. Some managers are wondering whether the additional fifteen cents are given up in response to benefit performance high pressure salesmanship, or whether the variety is the attraction. The experience is worth observing on a wide scale.

▲

DIVIDING THE BOX OFFICE RECEIPTS

WHEN the moving picture show business became a highly competitive enterprise on the part of theatre chains and theatre managers, it was natural that there should forge to the front here and there inquisitive economists with a bent for statistics. Aggressive struggle on the part of theatre managers reflects dwindling margins of profit. When theatre managers realize that notwithstanding large gross receipts, net figures are of discouraging volume a fertile field is presented for the analyst of costs all the way back to the source.

During the past year distributor organizations particularly have been far from backward in criticizing picture production costs. Rivalry on the part of producers seems to have called for much promotional literature which included references to salaries paid "stars," and broadsides of alluring photographs picturing the castles, steads, ranches, estates, etc., in the Hollywood area owned by these prominent men and women, all of which reflects enormous annual incomes.

Aside from what the distributors think of the disproportionate whacking up of box office receipts, there are the engineers, technicians and projectionists who have to be pretty liberal minded fellows to agree that a successful comedian or a successful crooner is worth as much in the scheme of things as are thirty projectionists or twenty engineers.

However, the survival of the fittest and old man economics are blood brothers, and the older they become—the longer they go, the closer together they are likely to work for the family welfare. In the moving picture production business even now there are hopeful signs in these respects and it may be that in the end all will be well.

Donald McNicol

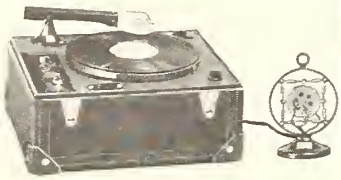
Editor

WEBSTER

CHICAGO SOUND AMPLIFYING DEVICES

Condenser Power Unit—Eliminates batteries in the operation of condenser microphones.

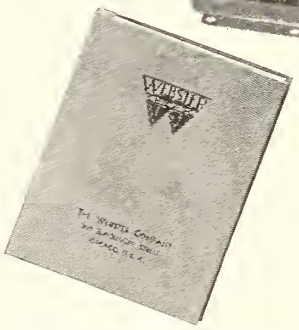
M 463—Junior size public address amplifier.



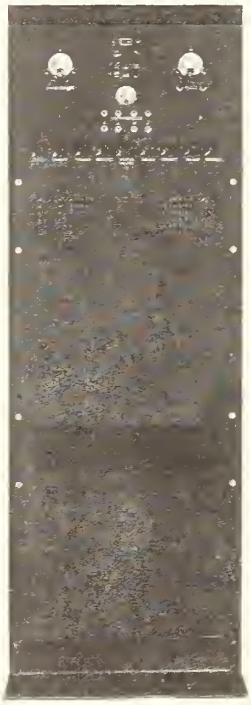
New Webster Portable. Small, light and powerful public address system.

NC 72—Complete public address amplifier.

Webster Transformers—Ten Specific models for a variety of uses. Special Transformers designed for your particular purpose.



Send your request for catalogue on your letterhead—please.



R 2-30 — Complete Amplifying Equipment—Phonograph, radio and microphone (includes radio chassis). This system will furnish sufficient power for eight or more dynamic speakers at high volume and several hundred speakers at lower volume. Our catalogue describes the complete line.

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has always been the fetish of Webster Engineers—but never before have they risen to the heights attained in the 1932 Webster Line. ¶ We present to the industry the most complete line of Sound Amplifying Equipment ever offered—each item fashioned to the exacting Webster Standards and priced according to 1932 Economy Standards. ¶ Included in this comprehensive line are permanent and portable address systems—broadcasting apparatus—sound recording amplifiers—amplifiers for home talkies—phonographs and coin-operated phonographs and theatre projectors—transformers for any use, a few of them pictured herewith. ¶ Complete descriptions may be found in the Illustrated Catalog for 1932 which is now available. Ask for it—*Today*.

WEBSTER COMPANY

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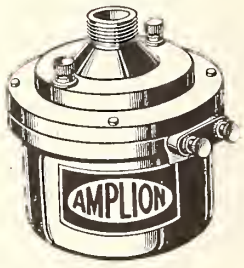
AMPLION OCTOPHASE SPEAKERS



AMPLION
OCTOPHASE
GIANT DYNAMIC
AIR COLUMN UNIT

Weight 15 lbs.
Height 5¾ in.
Diameter 5¾ in.

Field Coil Resistance 5 ohms.
Field Coil Supply 6 volts D. C.
Field Current Consumption 1.2 amperes.
Voice Coil impedance 16 ohms.
Maximum Capacity 25 watts.
Permanent Capacity 6 watts.
Shipping Weight 21 lbs.
Shipping Dimensions 12x12x12 in.
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It is those overtones from 5000 to 8000 cycles which give character to speech. Can you afford to nullify your entire equipment by employing speakers which can not reproduce these frequencies.

for

AUDIBILITY - INTELLIGIBILITY - DURABILITY
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OCTOPHASE

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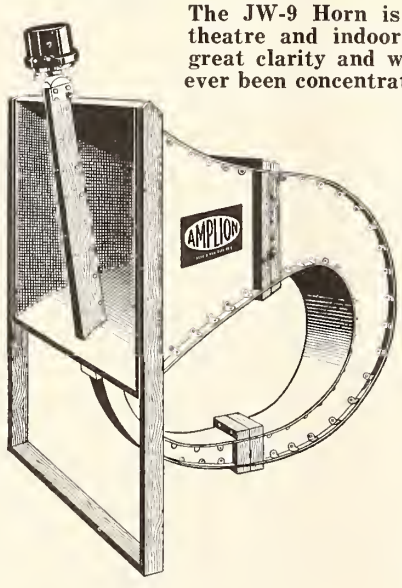
AMPLION NINE FOOT THEATRE HORN JW-9



The JW-9 Horn is especially designed for theatre and indoor use. No horn of such great clarity and wide frequency range has ever been concentrated into so small a space. It covers the full speech range perfectly preventing over resonance and muffling on base notes. As a reproducer of music, it possesses a brilliancy impossible of attainment in horns made of soft materials. Its nine foot air column and wide bell, assure excellent performance on the low notes.

List Price $95.00

Air Column 108"
Bell 34" x 26"
Bell Area 720 sq. inches
Weight 33 lbs.
Shipping Wgt. 70 lbs.
Shipping Dimensions 38" x 33½" x 39"
Angle of Spread measured at lip of bell 36°
Height 42" Width 34"
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BELL 35 M.M. SOUND-ON-FILM PROJECTOR

A TRULY PROFESSIONAL sound-on-film projector that is in the fullest sense of the word *portable*. The entire equipment disassembles into compact, easily handled units, no one of which weighs over 65 lbs. Can be easily transported in the back of a standard sedan automobile and handled by one man.

BELL Equipment is easily in a class by itself in such important features as ease and certainty of control, freedom from fire hazards, full automatic lubrication, quality of sound projection, compactness and portability.

Designed by acknowledged experts with a full knowledge of the rigid requirements in the portable field, BELL Equipment is far in advance of all competition in adaptability to every reasonable condition possible to encounter.

THE BELL SINGLE or Industrial Unit is provided with 1,000-ft. or 2,000-ft. reels and magazines, and consists of one right projector, 5-stage Amplifier and Uni-Remote-Control, mounted in metal case and two dynamic speakers mounted in carrying case. The total weight is 150 lbs. complete with legs, carrying cases and accessories. Price, $1,250 complete.

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The first simple-to-operate, recording, reproducing electric phonograph known as the

SAMSON PAM-O-GRAPH

is now available to make aluminum records in sizes from 6″ to 12″ practically equal to those produced in professional studios. It will play back voice records made by itself so any person can immediately recognize the voice of the person who made the record and will also play any standard make of (78 r.p.m.) record.

To operate simply plug cord into ordinary lamp or wall socket connected to the usual 110-volt, 60-cycle, a.c. circuit. A neon light bulb, acting as a visual monitor, will then glow to show you how to speak at correct volume for best recording.

The PAM-O-GRAPH comes complete with tubes, microphone, microphone stand, 15 feet of microphone cable, recording needle, and special playback needles.

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Projection Engineering

DECEMBER, 1931

Standardization of apertures for sound pictures

Basis for Standardization

This is the second step in the standardization of apertures begun by the Academy in 1929. It is made possible now by the decrease in the use of sound-on-disc and the increasing number of theatres which use a reduced three-by-four proportional aperture.

The original Academy specifications were made to take care of an emergency situation. A large number of theatres using sound-on-film had given up the nearly square movietone screen shape for mechanical and other reasons and were insisting on using a reduced aperture in three-by-four proportion.

Consequently the heads and feet of characters were being cut off since the studios at that time were photographing for the full height of the frame. The Academy made a national survey of the situation and found that something had to be done although there was still so much full frame disc release that it was too early to standardize. As a temporary measure the Academy then recommended that all vital action be kept within a three-by-four rectangle marked on the camera glasses of such size that the picture would not suffer when projected through a reduced proportional aperture. For the past year cameramen have thus had to fill about twenty per cent of their frame—the ten per cent of sound track area, five per cent at the top and five per cent at the bottom—with non-vital action or unessential views of the set.

The proposal now is to mat off this useless space in the camera and standardize the American industry on the three-by-four picture proportions preferred by the theatres. By careful calculations it has been found possible to use a little more image area on the film than has been included inside the marks on the ground glass and thus give four per cent more image area for vital dramatic action to reach the screen.[1]

[1]NOTE: *The question of the relation of the motion picture aperture to a possible aperture for television was brought to the attention of the sub-committee by the Television Committee of the Radio Manufacturers' Association. The standard specifications allow for an adaptation to the requirements of television when such adaptation may be commercially desirable.*

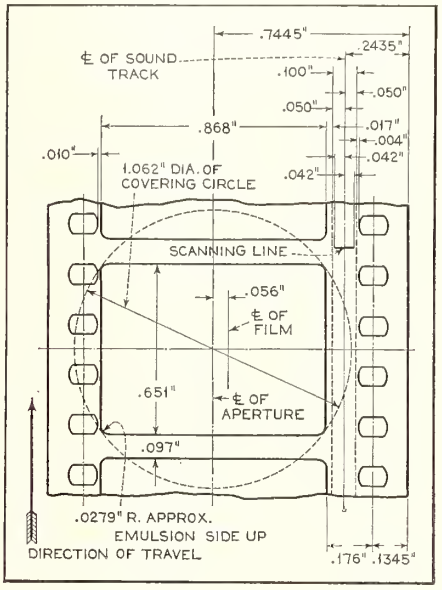

Fig. 1. Academy standard camera aperture.

The proposed standard apertures for all pictures are:

New Camera Aperture: .651" x .868"
(Corners to be rounded by an arc of a circle of .0279" radius.)

Replacing the present:
Ground glass markings of: .620" x .835" in the
Mitchell aperture of: .720" x .923" and the
Bell & Howell aperture of: .720" x .969"

New Projector Aperture: .615" x .820"

Replacing the present:
Most commonly used proportional of: .600" x .800"
Movietone aperture of: .680" x .800"
Old silent aperture of: .680" x .906"

Advantages to the Studio

1. *Economies.* Cinematographers estimate that from a half hour to an hour a day now spent in setting up for composition in three apertures—full frame, movietone frame and proportional—can be saved or devoted to improved photography.

Scaffold lights can be lowered from three to five feet, thus making possible a reduction in the wattage or number of units.

The tops of large sets can be lowered by as much as six feet and all sets can be reduced in width by nearly ten per cent without making any change in the placing of essential action and props as photographed for the past year.

2. *Improved Quality.* A single aperture will make for better composition on the set for both the cinematographer and the director.

The studios will be assured that the picture will be projected as it was pho-

▲

Technical bureau report No. 24 of the Academy of Motion Picture Arts and Sciences, of which Lester Cowan is executive secretary, is now being studied by studio staffs. Specifications have been worked out by a committee of the Academy Producers-Technicians Committee in consultation with technicians representing the various studios. The report has to do with desired standardization of the size and shape of the picture frame in three-by-four proportion for all photography, release and projection of sound-on-film, sound-on-disc and silent pictures from 35mm. film. . . . If a majority of the studios agree to standardize, the proposal will be presented to theatre and release organizations for consideration and approval. . . . If the standard is adopted by the industry, projectionists can render important service by seeing to it that apertures and screen masks are so adjusted that there is shown all of the picture the studio photographed.

tographed. Projectionists have had wide leeway in framing and no guide to show them when their proportional aperture was centered until they saw heads or feet cut off on the screen.

Microphones can be lowered from three to five feet, resulting in an obvious advantage in sound quality and convenience for the sound department.

Camera lenses can be recentered on the new aperture for better optical coverage.

Advantages in the Theatre

1. All pictures can be projected through a single standard aperture, doing away with movable flippers and changes of screen masks, aperture plates and lenses during the show.

2. The frame lines just outside the aperture as they used to be for silent pictures will be a help to the projectionists in keeping in correct frame. If the picture should momentarily go a little out of frame the projectionist will be warned by seeing a frame line, but as the lines are wide the misframe can be corrected before the audience notices it.

3. Standardization of exact dimensions by the studios will give the projectionist more uniform prints from the various companies.

4. Theatres now using reduced proportional apertures will gain four per cent more screen image without additional magnification.

5. Theatres now using the movietone aperture or the old silent aperture will gain the advantage that the studios can fill the whole area of the new standard aperture with essential dramatic action and will not have to leave a border of unimportant picture.

Equipment Changes Required in Studios

In Cameras. New apertures at a cost of about $25 per camera; new ground glasses; adjustments to recenter lenses.

In Laboratories. Minor adjustments depending on the present practice followed by the laboratory.

In Art Departments. New camera angles.

In Viewing Rooms. Adjustment of projector apertures and screens.

Equipment Changes Required in Theatres

1. Theatres now using reduced proportional apertures:
   a. File out apertures to larger size or insert new plates.
   b. Enlarge screen by about four per cent of area.
2. Theatres now projecting in movietone proportion:
   a. Insert new aperture plates.
   b. Either move the screen masks in from the top and bottom.
   c. Or, install shorter focal length lens and widen the screen.
3. Theatres now projecting full frame silent or full frame with disc sound:
   a. Insert new aperture plates.
   b. Recenter head of projectors.
   c. Either, move screen masks in on all sides.
   d. Or, install shorter focal length lens to enlarge image to present screen.

Detailed Specifications for Proposed Standard

Specifications for the standardized apertures as worked out by the subcommittee in consultation with studio and equipment company technical representatives are shown in the attached drawings.

Camera Aperture

The dimensions indicated in Fig. 1 provide the maximum aperture which will leave an adequate margin of safety. It should be emphasized, however, that laboratories should print both picture and sound track with the greatest possible accuracy. In the drawing the center line of the right-hand side sprocket holes is used as the base center line for calculating all dimensions, since cameras and printers register at this point.

Projector Aperture

The projector aperture dimensions, Fig. 2, have been stated on the basis of projection on the level as no uniform provision for the keystone effect can be made. The calculations have been carried out with due regard to the fact that in projectors the film is controlled at its right-hand edge.

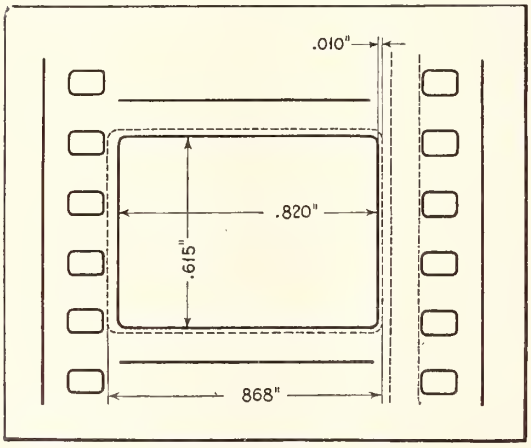

Fig. 2. Academy standard projection aperture.

Sound Track

The drawing, Fig. 3, is a detail from Fig. 1 to show the minimum requirements for sound track width and location which were agreed upon by the heads of studio sound departments and incorporated in the subcommittee specifications.

Minimum and Maximum Sound and Picture Areas

Fig. 4 is a composite view of the dimentions resultant from the calculation of shrinkage and mechanical tolerances from which Fig. 1 was derived. Some of the factors and conditions considered are given in the following analysis by J. A. Dubray of the subcommittee:

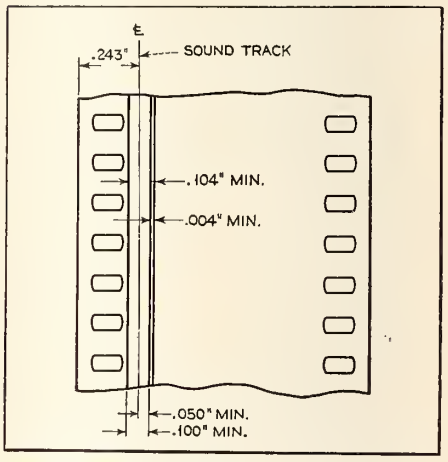

Fig. 3. Detail of minimum requirement for sound track.

1. *For Negative Films*—a. The plus and minus camera tolerances which include the location of the aperture (constructional tolerances), the size of the aperture (constructional tolerances) and the side weave of the film on the register teeth of the intermittent mechanism.

b. The plus and minus tolerances which must be allowed in accumulating the camera tolerances with a ½ per cent film shrinkage.

2. *For Positive Films.* c. The plus and minus tolerance required in printing a positive and calculated first from the effect of registering the positive film against the right-hand side of the teeth of the main printer sprocket while the negative registers against the left-hand side; second from the effects of registering the positive and the negative films in the opposite direction. Both cases for unshrunk positive and accumu-

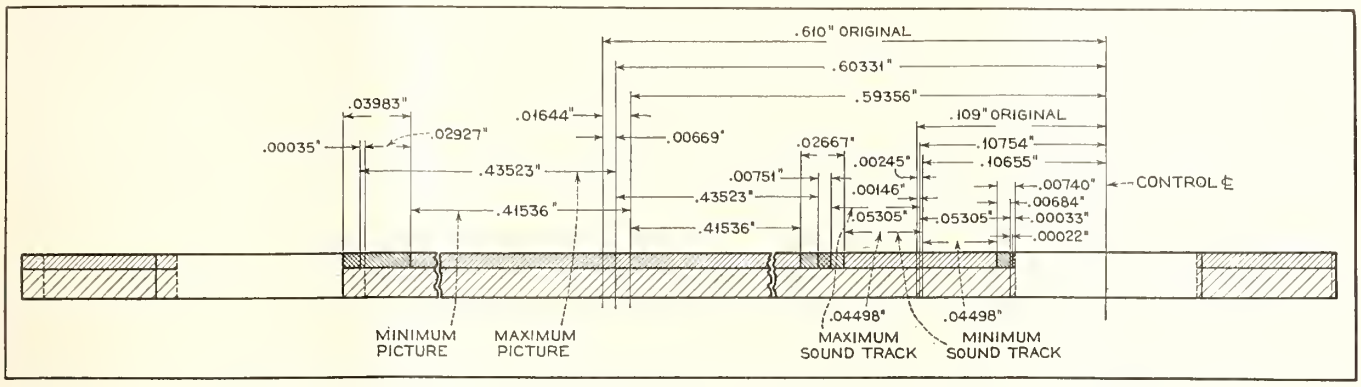

Fig. 4. Minimum and maximum sound and picture areas of positive using s procket center line for register.

lating with the tolerances arrived at (b).

d. The plus and minus tolerances calculated from the (c) tolerances plus a positive film shrinkage of ½ per cent.

e. The plus and minus tolerances calculated from the (c) tolerances, but with the addition of a positive film shrinkage of 1½ per cent.

The results obtained from the foregoing have been derived with the assumption that the negative has only shrunk ½ per cent.

However, since the shrinkage effect constantly progresses through the printing process as well as while the films are stored away, the calculations have been extended to include a greater negative shrinkage.

The following series of computations was carried accumulating the plus and minus camera tolerances, with the tolerances necessitated by the various conditions expressed above, with the exception that a maximum 1½ per cent shrinkage of the negative was considered instead of the minimum ½ per cent.

3. *For Negative Films.* a′. Camera tolerances same as for (a).

b′. Tolerances resulting from accumulation of (a′) and 1½ per cent negative shrinkage.

4. *For Positive Films.* c′ Tolerances required in printing with unshrunk positive for both conditions of film registration expressed at (c), but accumulating tolerances calculated at (b′).

d′. Tolerances calculated through the accumulation of tolerances at (c′) and ½ per cent shrunk positive film.

e′. Tolerances calculated through the accumulation of tolerances (c′) and ½ per cent shrunk positive film.

The latest being the extreme case, accumulating a maximum permissible shrinkage and all constructural and register tolerances taken from the camera, the registering tooth, the processing of both positive and negative and those of the printing of the positive film, which are due to the differences in shape and dimensions of the positive and the negative perforations.

The above method of determining shrinkage and mechanical tolerances has resulted in the determination of a maximum camera aperture as illustrated in Fig. 1.

Taking the above dimensions and computing according to the accumulated tolerances determined at (d), (e), (d′) and (e′), the maximum and minimum dimensions of sound track and picture area of positive film are derived as shown in Fig. 4.

Possible Objections to the Proposed Change

1. A large part of foreign release is now on full frame disc, and foreign exhibitors are used to showing American product in this way. This is probably the most important objection to the proposed change, even though foreign release is a comparatively small item. However, the same considerations of studio economy will also apply to foreign producers and it is probable that they will follow Hollywood's lead. Foreign theatres now showing full frame can make the same adjustments American theatres have made. If they make no adjustments at all the picture will not be hurt except to show a heavy black border on the top, bottom and left side.

2. There will be a period when prints with different apertures are circulating side by side. While this is true of any standardization, the committee considered that the advantages will far outweigh any temporary inconvenience. Theatres will be given the necessary instructions in advance and should not make the changes until they begin to receive most of their bookings on the new standard.

3. Many theatres are unable to afford expensive changes in equipment. In answer to this it may be pointed out that this change puts no burden on the theatre. The new frame can be projected if necessary without any changes in apertures or screens whatever and the only harm will be that a black border may show around the picture. The theatre can get rid of this by installing new aperture plates at a maximum cost of $3 and putting a rim of black paint around the screen or moving the screen masks in at very slight expense.

4. If an individual theatre does not want to install shorter focal length lenses and has been showing silent pictures or sound-on-disc pictures through the old silent aperture, the change will reduce its screen size by about eighteen per cent. If a theatre has been showing sound-on-film through a movietone aperture the change will reduce its screen area about seven per cent, unless shorter focal length lenses are installed.

In answer to these statements it should be pointed out: first, that the area being matted off has not contained any vital action during the past year and so has contributed little to entertainment value; second, that standardization of the three-by-four proportions responds to a strong demand from the theatre field; third, that to the increasing number of theatres using a reduced proportional aperture the change will mean a four per cent larger screen image without additional magnification.

EIGHTY-FOUR UNITS SHIPPED TO INDIA

BUSINESS in the motion picture theatres of India appears to be booming, if the constantly increasing number of installations of sound reproducing apparatus may be taken as a criterion. Within the past week Van Ness Philip, manager of the foreign department of RCA-Photophone, Inc., has received orders for ten complete units of equipment from Madan Theatres, Ltd., and Alex Hague, authorized distributors for Photophone in Bombay, and to these most recent orders may be added seventy-four units which have been installed in theatres in various sections of India during the past eight months.

Madan Theatres, Ltd., has been producing sound pictures for the past six months, having purchased an RCA Photophone recording channel for that purpose at the time of Fram J. Madan's visit to New York last winter. Plans are now in the making for even more extensive production activities.

Selling public-address equipment and service

WRITING in the *Broadcaster and Wireless Retailer,* London, James Deers puts forward excellent suggestions which if acted upon should result in furthering the sale of public-address systems and rental of service.

Mr. Deers says:

"Your first step to secure p-a. work should be to circularize the secretaries of all local clubs and the potential users of equipment.

"For this purpose you will require a mailing list. The nucleus of this can be obtained from the 'clubs' section of local directories.

"It can be further added to by watching the small advertisements in the local newspapers and extracting addresses of clubs advertising for new members, usually under the 'Sports' section.

"A big percentage of your work, however, should ultimately come from recommendations and from bookings made on the spot by potential users present at functions where a public-address system is used.

"Here is a suggestion for the letter to small sports clubs:

" 'Dear Mr. Secretary:—It must be quite a problem to you at times to know what to do about the music for your occasional informal dances. The cost of an orchestra is often hardly justified, while a phonograph makes itself heard only over a small area.

" 'What is really needed for this sort of function is our sound reproducer service (described in the enclosed leaflet).

" 'The expense? Very low indeed. For instance, you can have equipment on loan for an evening capable of covering up to two hundred people dancing for $00.

" 'If you would like to hear the equipment we should be glad to arrange for you to visit a function where it is in use, or to demonstrate in your own clubhouse—of course, without charge or obligation.'

"After allowing a week or so to elapse, your next step should be to follow up with a personal call. This is very advisable, as it enables one to weed out the unlikely 'prospects' at once and also to get into personal touch with the secretary.

"In the directory, each club may seem an equally likely prospect, but a visit will show which can immediately be struck off the mailing list.

"In many cases your application to the secretary has to be referred to the committee for a decision. For this reason, where possible, a demonstration should be arranged in the actual club premises with the committee present, as many people are still surprisingly skeptical of the capabilities of modern p-a. equipment.

"It is difficult to give definite figures for charging. Apart from the capital cost of the equipment there are a number of variables. These include operators' wages, transport and installation costs. Also tube and record replacements have to be covered before profit can be shown.

"For a function where amplified speech for announcements as well as music is provided, anything from twenty to fifty dollars might be charged, depending on the size of the crowd and the financial position of the club.

"For dancing only you will have to compete in price invariably with the 'semi-professional' dance band, of which there are now some thousands, consisting mostly of youths employed regularly in other directions who turn to dance-band work as a spare-time money-making hobby, and who can afford, therefore, to play for very little remuneration.

"Particular care should be taken in the compilation and use of record libraries.

"Discrimination in the use of suitable types of orchestration also will pay. For instance, a young crowd of tennis-club people will appreciate a program of 'hot' or rhythmic style dance records, whereas a social club with members of maturer age would prefer more melody rendition and will invariably also call for a good percentage of waltzes.

"Handle the business side with the same care and consideration you give the technical details of p-a. work and you will find your clientele growing with each successive function satisfactorily carried out."

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The skating rink music problem

By R. O. Elmgren

THERE are hundreds of roller and ice skating rinks in the country whose managers would like to install modern sound equipment for furnishing music to take the place of other mechanical devices they now use and which do not furnish the quality of music that is desirable. Many of them employ bands or orchestras to furnish music, but this is an expense many rinks would like to get away from.

Many rinks throughout the country have already installed sound equipment to furnish music from phonograph records. They obtain records made by the leading manufacturers suitable for skating. This is not always satisfactory, for it does not give them the full benefit of the economy of a sound system, nor does it allow them a system which needs practically no attention. They have to purchase records with suitable music and time, which are few; and often the reverse side of these are entirely unsuitable. Usually some one must attend to the equipment to see that records with the proper cadence are played.

I have obtained a goodly number of the records recommended by several of the foremost manufacturers as being suitable for skating. I find this: First, very few of them have the exact time required, which is 56 beats to the minute. Some are slower and some are faster. Individually they could be played and the speed regulated so that the resulting music would have the same cadence constantly, but this will not do, for the proper thing to use is an automatic changer to change these records, and this cannot be done if the time is not alike on all the records. Second, all of these records are band or orchestra numbers, recorded for entertainment as good music and delightful selections. If they all had the same time, they could get by, but they still lack something that is required for proper skating music, and that is an accentuation of the tempo; the swing, the time is not emphasized!

Here, then, is the solution to the problem, which would mean increased sales for the sound equipment industry and would provide a new and wide outlet for the product of record manufacturers and would prove a rich field for the first to go into it. This would be

(*Concluded on page* 25)

A new system of color television

By Henri F. Dalpayrat

IT is generally believed that the art of television is still in its infancy and just recently emerged from the experimental stage, but this is not wholly true and does not accord with the facts. All the fundamental principles of television were known more than thirty years ago, but due to the lack of certain necessities it was then only possible to speculate on theories which, although sound in principle gave but crude and inefficient results when reduced to practice.

The recent improvements made in photoelectric cells, neon tubes, crater tubes, better scanning systems and a better understanding of the principles of electron discharge devices, resulted in the production of several television systems, among which the three best known are: First—the neon plate tube and perforated disc; second—the crater lamp and the lens disc; third—the cathode-ray tube. These systems offered to the public would give interesting performances, but the majority of manufacturers prefer to wait for ultimate developments, especially in new transmission systems which will make possible the reproduction of pictures composed of several hundred lines. When the problem of transmitting such a large number of modulated frequencies over a narrow channel is solved, larger pictures and wider scenes with finer definition of details will be available. Mechanical systems are cumbersome since they give crude results and can only produce small pictures, being limited by the number of holes or lenses.

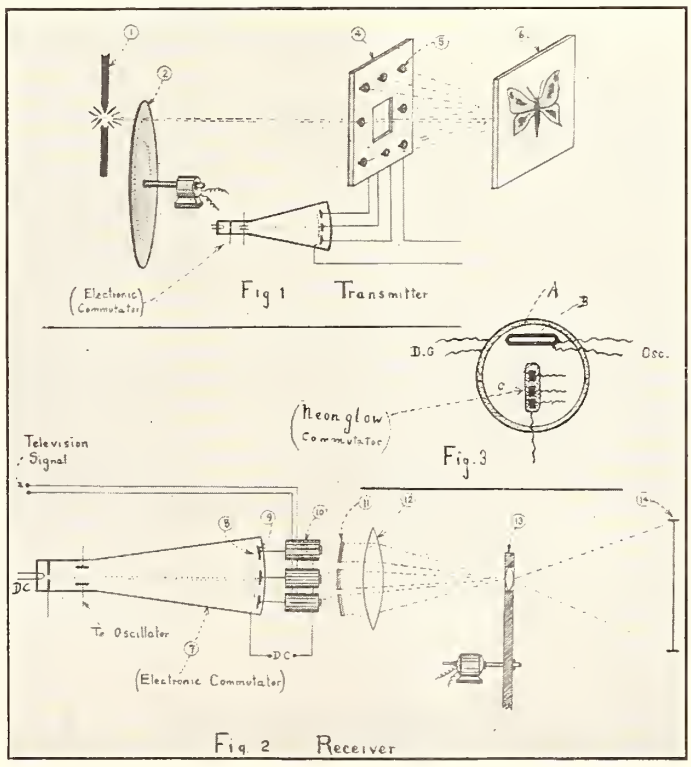
The Kerr cell system is regarded as impractical for home use on account of its high cost of operation and its mechanical complications. The cathode-ray tube is advantageous perhaps only for small pictures and may become expensive when large, clear pictures are desired, as the size of the tube has to be increased in proportion and much more power has to be delivered by larger and more expensive accessories. A television engineer has recently designed a new system of projection where the signal modulates a light which is scanned electrically by magnetic fields and projected forward from the device upon a large screen.

It is easy to visualize the enormous possibilities of television broadcasting when applied to advertising purposes. A verbal description of an object advertised by radio is always indefinite, as each person forms his own opinion, which is different from that of others, and which will probably be far from the actual picture of the object. With television pictures, the object is better understood, and with colors the picture glows with life-like reality. The interest of the television observer is much increased when the object advertised is seen really as it is.

The importance of colors in television is evident, although this fact seems to have been neglected. It is improbable that cathode-ray tubes will ever be designed to reproduce colors. Other systems employing mechanical motions have numerous limitations, and it may be that they will disappear within a year or two. What remains to produce an efficient system able to project either black and white or colored pictures? Well informed experimenters are convinced that it will be a new sort of electron device operating upon a new principle. Perhaps a system similar to the one described herewith might become popular in the near future as it has all the necessary qualifications without any of the above mentioned limitations.

Fig. 1 shows the transmitter of the new system of color television. Fig. 2 is the receiver and Fig. 3 is a new "electronic" commutator, the general principle of which is used in a magnetic light projector. In Fig. 1 (1) is an arc light which throws rays of light through the perforations or lenses of the scanning disc (2); upon the subject to be televised (6). The light reflected reaches the photoelectric cells (5) which are mounted on the window (4). This window contains several groups of different cells. One group is mostly sensitive to red light and has color filter screens passing only that color. Another group is more sensitive to blue and has its own color filter. Another group is sensitive to green, and so on. For the purpose of illustration and for the sake of simplicity only the three fundamental or primary colors, blue, red, green are to be used in the present scheme. Each group of photoelectric cells is connected to its contact plate in the "electronic" commutator.

This device consists of a tube very much like the cathode-ray tube except that only one set of deflecting plates is used and that the wide end of the tube contains a screen grid which accelerates the speed of the electrons and three separated anodes which consecutively col-



Elements of color television system.

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Here are described new possibilities in the way of television betterment

lect them as the beam is swung up and down under the deflecting action of the electrostatic fields. The rate of deflection per second will determine the number of times each commutator plate will be connected and disconnected within that time. For example, if the picture frequency transmitted is 21 frames per second, a rate of deflection in the commutator of 7 times per second will paint each transmitted frame a different color (or shades of that color) and the superimposition of the different frames at the receiver will reproduce all the natural colors of the subject being televised. A minimum of 12 frames per second is necessary to produce the illusion or continuity upon the optic nerves of the human eye. Twenty frames give even better results and a greater number of frames (about 32) would result in steadier, non-jumping pictures.

Unfortunately we are again limited by the number of frequencies permissible within certain limits now allowed to television broadcasting stations. However, for all practical purposes the 20 frame per second value is quite satisfactory. When each frame is to be painted separately the problem is different and the difficulties also increase. To avoid the colors from jumping or moving beyond the object it would be necessary to repeat the same color at least 20 times a second, and as three colors are used it would be necessary to transmit 60 frames per second. This would be impossible to accomplish with mechanical devices, but certain new systems of electrical scanning now being experimented with will probably overcome this difficulty.

Supposing, however, that 21 frames a second are transmitted. Each color will be repeated seven times in a second and in that case if the commutator has three contact plates the frequency of deflection will be 7. The mode of operation of this system is as follows: The photoelectric cells (5) receive the light reflected from the object (6); this light varies in intensity with the color or shade or brilliancy of the object. The photocells are divided into three different groups and each group is made up of cells having different characteristics. The commutator connects successively each group of cells to the transmitter circuit and the voltage variations given by those cells are amplified and transmitted. For example, a part of the object which is red will reflect a certain amount of light which will be reflected upon all cells, but only cells having a red color filter will allow this light variation to pass. The process of color selection is then automatically performed by the color filters and the different cells of various characteristics.

The problem of assorting these colors is accomplished by the commutator. Supposing that at any given time the group of cells receiving more blue light is connected at the transmitter and that at exactly the same time another commutator working in synchronism connects a contact plate (9) connected to a light source (10) with a blue filter (11), then that color will be projected by lens (12) upon a lens disc (13) and then upon the screen (14) with exactly the same brilliancy or shade of color as it was transmitted. The same process is repeated over and over again. Each frame is painted one color or shade of that color and all the 21 frames superimposed one upon another blend and reproduce all the natural colors of the subject being televised.

For the sake of simplicity mechanical scanners are shown, but the scanning can also be done electrically within the light sources and thus eliminate all mechanical motions. Fig. 3 shows a new and very interesting form of "electronic" commutator. A large electromagnet winding is connected to a source of direct current. A special neon tube containing one grid made of metallic screen and of three or more collector plates, is placed in the center of the magnet so that the top plate is exactly in the center of the field. The electromagnet repelling electrons within that tube from all sides, focuses them to the center of the field, the top plate glows and current flows through the circuit. By placing an extra field within that field, a saw-tooth oscillator for example, the focal point of the lines of force is displaced up and down and causes the electrons to move from one plate to another, thus effecting a commutating action. This device can work at extremely high speeds or rate of commutation.

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Innovation to stage production in sound system for Norman Bel Geddes' "Hamlet"

ANOTHER innovation for legitimate stage productions was contributed by Electrical Research Products, Inc., with the opening in New York of Norman Bel Geddes' "Hamlet" at the Broadhurst Theatre, on November 5. Shakespeare's century-old lines were enhanced by modern science in the form of music and sound effects coming from the loudspeakers of a Western Electric music reproduction system.

Special recordings have been made of a type similar to those used for electrical transcription programs broadcast over the radio. Twin turntables, operating at 33 1/3 revolutions per minute, are so arranged that there is no pause in switching from one record to the next, and also provide for superimposing one sound effect upon another. This superimposing facility is used to particularly marked advantage in the ghost scene, during which the weird sound of the wind at midnight continues through a brief musical selection which heralds the appearance of the ghost.

The sound from the phonograph records is reproduced through five loudspeakers located at various positions back-stage and controlled by a switching system which permits selective or simultaneous operation. Thus, in the mob scene by switching from one speaker to another in sequence the sound gives the illusion of a crowd surrounding and approaching the citadel, and the weak, far-off murmurs and cries develop to a great climax and loud cheers when the gate is finally broken down.

The prelude, overture and entire musical accompaniment to the show is reproduced over the system—there being no orchestra or other conventional music used in connection with the play.

The reviews and audience comments in Philadelphia, where the Bel Geddes production had its tryout, were enthusiastic about the entertainment value contributed by the most unusual music and sound effects.

"Hamlet" marks the fourth recent major stage production in which Western Electric sound equipment has been used to marked advantage. The first was the "Miracle of Verdun," the Guild production where synchronized music and sound were used to heighten stage realism. The George White "Scandals" at the Apollo Theatre has a public address system installed to reinforce the voices of the actors and singers, thus making rear seats as desirable as the front row from a hearing standpoint. In the new Earl Carroll Theatre where the "Vanities" is meeting with such success, a complete system of general reinforcement, including facilities for curtain call, announcements, manager's call system and reproduction of the stage program throughout the dressing rooms, is an important added service.

Some aspects of a modern sound recording system

DESIGN and construction of sound recording equipment for use by the average cameraman is quite a different problem than that presented by equipment used in the large studios by skilled technicians. In the large studios, the equipment is tested daily with precision instruments and adjustments made to insure maximum quality output. Also the equipment is used under ideal conditions compared to what the small producer has to contend with. With the equipment in daily use, any trouble that develops is immediately detected and corrected. The free-lance producer may not use his equipment for days and his success depends upon the dependability of his apparatus.

With these facts in mind, the recording equipment here described is designed and built primarily for the small producer. It is gratifying to note that equipment put in use over two years ago is still operating at maximum efficiency. The recorder can be furnished in either the single or double system. The double system is advocated for several reasons. The recording head and motor can be furnished mounted in a durable carrying case, the recorder and case weighing only 45 pounds. Compared to the single system, the double system adds only one additional carrying case. The flexibility of control of the sound and picture negative in processing and cutting is in itself enough to warrant the double system. Another advantage is less grain when using positive film for the sound negative. For those who own Bell & Howell cameras and do not have enough business to warrant the purchase of the double system, the recording lamp can be mounted in the rear of the camera allowing the sound to be recorded on the same negative with the picture. Greater care must be exercised in regulating the exposure when photographing both sound and picture on the same negative. By developing in fine grain developer, excellent results can be obtained by this method.

The main casting of the recording head is aluminum. All shafts hardened and ground run in bronze and ball bearings. The top is recessed to receive a standard Bell & Howell magazine. In order to assure constant speed of the film past the light beam, a double "filter" system is used. As the film is being exposed it passes around a revolving drum mounted on a shaft upon which is attached an accurately balanced flywheel. The sprocket pulling the film around this drum is isolated from the driving mechanism by a filter of advanced design. This sprocket is mounted on a shaft of generous diameter which precludes the possibility of damage, should the film pack up or wrap around the sprocket. A footage counter is located on top of the recording head. Motor and recorder are mounted upon a cast aluminum base as shown in Fig. 1.

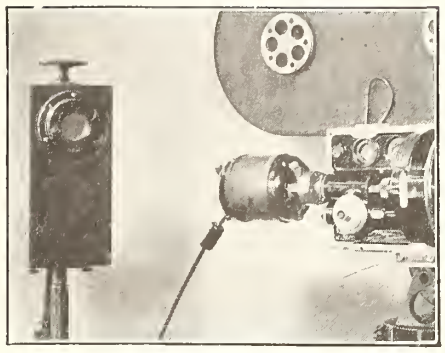

Fig. 1. Motor and recorder mounting.

Motors furnished depend upon power supply. Any voltage or frequency, alternating or direct current. Equipment mounted in sound trucks is operated by two 6-volt automobile batteries. These furnish sufficient power for one day's operation of recorder and camera.

A modified recording head is used for high quality sound on film reproduction. The recording lamp is replaced by an exciting lamp and highly corrected lens. A prism located inside the drum picks up the modulated light and carries it to a photoelectric cell.

A reproducer of this type is essential for high quality reproduction.

In order to investigate the possibilities of recording sound on 16mm. film, the speed of a standard 35mm. recorder was reduced 2½ times to equal the speed of the 16mm. film. Using a narrower slit, frequencies up to 4500 cycles were easily recorded and reproduced. Quality compares favorably with that of the best commercial radio set. Special sprockets and reduction gearing will soon be available for 16mm. work. A recording lamp possessing excellent frequency characteristics is used in preference to the mechanical type of light valve. This lamp is very de-

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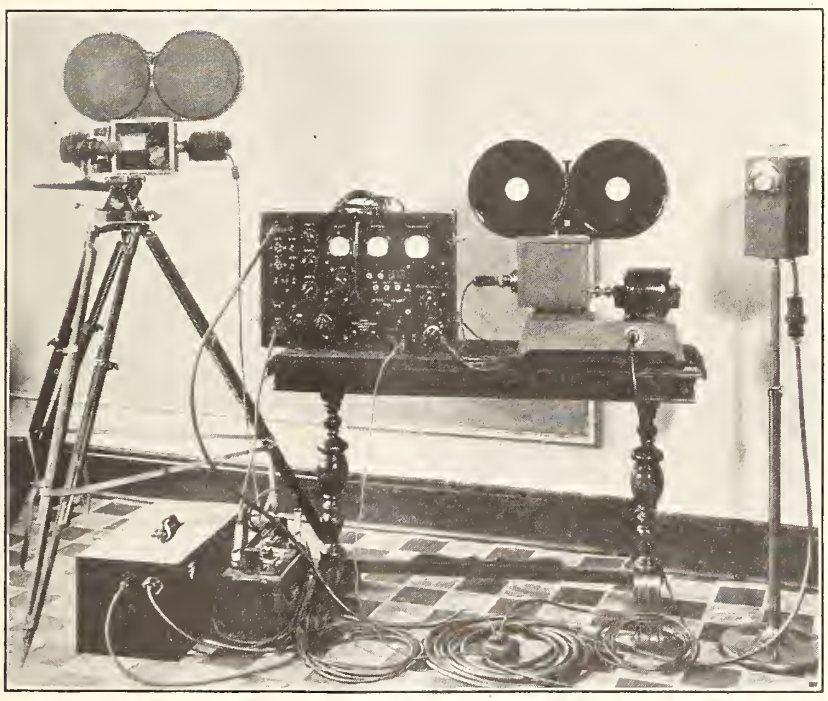

Fig. 2. Complete recording equipment.

Answers to examination questions

IN the October issue of PROJECTION ENGINEERING were presented the first ten of a series of questions intended as a month to month examination for projectionists. The answers to the first ten questions were published in the November issue, and in that issue appeared also the second set of ten questions. Herewith are presented the answers to questions Nos. 11 to 20:

11. When white light is passed through a spherical lens, both refraction and dispersion (the decomposition of white light into several kinds of light) occur. This causes a separation of the white light into the various colors, and causes images to have colored edges. This effect, which is most observable in condenser lenses, is due to the unequal refrangibility of the simple colors.

12. The distance from a point half way between the front and back combination of lenses to the film in the gate of projector while the film is in focus on the screen, is the equivalent focus. This can be obtained by measuring the distance between the front and back combination, then dividing by two and adding the result to the back focal length. The equivalent focus of a plurality of lenses in combination is the focal length of a simple lens, which will under all conditions form an image having the same magnification as will the given lens combination.

13. Lens loose in lens holder, dirty lens, buckling of film, incorrect film tension in gate of projector.

14. Sound is a wave motion. Wavelength is equal to velocity divided by the number of vibrations per second.

15. Sound waves, unlike light waves, do not travel in straight lines.

16. Sound does not travel at the same speed in different media, as a matter of fact an increase of speed will be shown with an increase of temperature. Sound waves travel at the rate of 1087 feet per second at 0° C., or 1126 feet per second at 20° C. Sound cannot be transferred through a vacuum, and in this respect differs from light and heat.

17. Ohm's Law is the fundamental principle on which most of the electrical mathematics are worked. Given two known quantities it is an easy matter to find the third unknown quantity. To find the amount of current, divide the voltage by the resistance, or to find the resistance, divide the voltage by the current, or to find the voltage multiply the resistance in ohms by the current in amperes.

18. A watt is the electrical unit of power. It is equal to one joule per second; that is, when one joule of work is expended in one second, the power is one watt. The power is obtained by multiplying the current by the voltage. The watt is sometimes referred to as the volt-ampere. A kilowatt is 1,000 watts, the common abbreviation for kilowatt is kw. The kilowatt-hour is a unit of energy, and is the energy expended in one hour when the power is one kilowatt. The volt is the practical unit of electromotive force. The volt is equal to the electromotive force which, when applied to a conductor having a resistance of one ohm, will produce in it a current of one ampere. The coming together of the two opposite polarities in an electrical system without any controlling device.

19. Reverberation is the persistence of sound in an enclosed space. It is measured by the time required for the sound to decrease to one millionth of the initial intensity. Sound waves travel by air 1,100 feet per second. Sound generated in a room proceeds outward in spherical waves from the source to the walls, where it is reflected, absorbed and transmitted. The reflected sound proceeds to a second wall, where it is again reflected, absorbed, transmitted and so on, experiencing from 200 to 300 reflections to an average sound. The greater the dimensions of the room or hall, the more prolonged will be the reverberations, other things being equal.

20. The control of apparatus from a point some distance removed therefrom, as, for instance, a motor generator located in a basement may be started, stopped and controlled from the projection room.

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EDISON'S LAST HONOR CONFERRED BY MOTION PICTURE ENGINEERS

The last honor bestowed upon the late Thomas A. Edison was that of honorary membership in the Society of Motion Picture Engineers; and this final tribute to the great electrical genius given during his lifetime was part of an important ceremony which took place recently at the New Ocean House at Swampscott, Mass.

In this connection Mrs. Edison requested a full story of the event, and Mr. Clement E. Kennedy, president of the New Ocean House, was able to furnish one of the menus used at the banquet of the S. M. P. E.

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NEW YORK AND CHICAGO SECTIONS OF S.M.P.E. ELECT OFFICERS

Officers for both the New York and Chicago Sections of the Society of Motion Picture Engineers have been elected for the ensuing year.

In the New York Section, P. H. Evans of Warner Brothers has been elected chairman; Donald E. Hyndman, Eastman Kodak Company, secretary-treasurer; and the managers elected are M. C. Batsel, RCA-Photophone, and J. L. Spence of the Akeley Camera Company.

For the Chicago Section, the officers are: R. Fawn Mitchell, chairman; Burton W. Depue, secretary; and Robert P. Burns and Oscar B. Depue, governors.

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PHOTOPHONE RECORDING FAR AHEAD IN ENGLAND

AMERICAN-MADE sound apparatus may be credited with having maintained constantly increasing activities in the studios of England, according to a report received by Van Ness Philip, manager of the foreign department of RCA-Photophone, Inc. With fourteen pictures as the high peak in production for the summer period, twelve of which were features and two of which were comedies, ten of the features and both of the comedies were recorded by the RCA-Photophone system. English studios which employ the Photophone system of recording are British International, British Lion, Gainsborough, Gaumont, First National Pathé, Ltd., Mansfield Markham, ARP (Dean) Studios, Teddington Film Studios, which are operated as a Warner Bros. subsidiary, Twickenham, Ltd., and Nettlefold Productions.

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METRIC PREFIXES COMMONLY USED WITH ELECTRICAL QUANTITIES

Meg-or Mega-	= 1,000,000	$= 10^6$
Myria-	= 10,000	$= 10^4$
Kilo-	= 1,000	$= 10^3$
Hecto-	= 100	$= 10^2$
Deka-	= 10	$= 10^1$
Deci-	=.1	$= 10^{-1}$
Centi-	=.01	$= 10^{-2}$
Milli-	=.001	$= 10^{-3}$
Micro-	=.000,001	$= 10^{-6}$
Milli-micro	=.000,000,001	$= 10^{-9}$
Micro-micro-	=.000,000,000,001	$= 10^{-12}$

The prefix "pico-" is sometimes used in place of "micro-micro."

Public address finds various uses

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The substantial character of the equipment now employed for public-address purposes indicates that this new art is destined to make rapid progress

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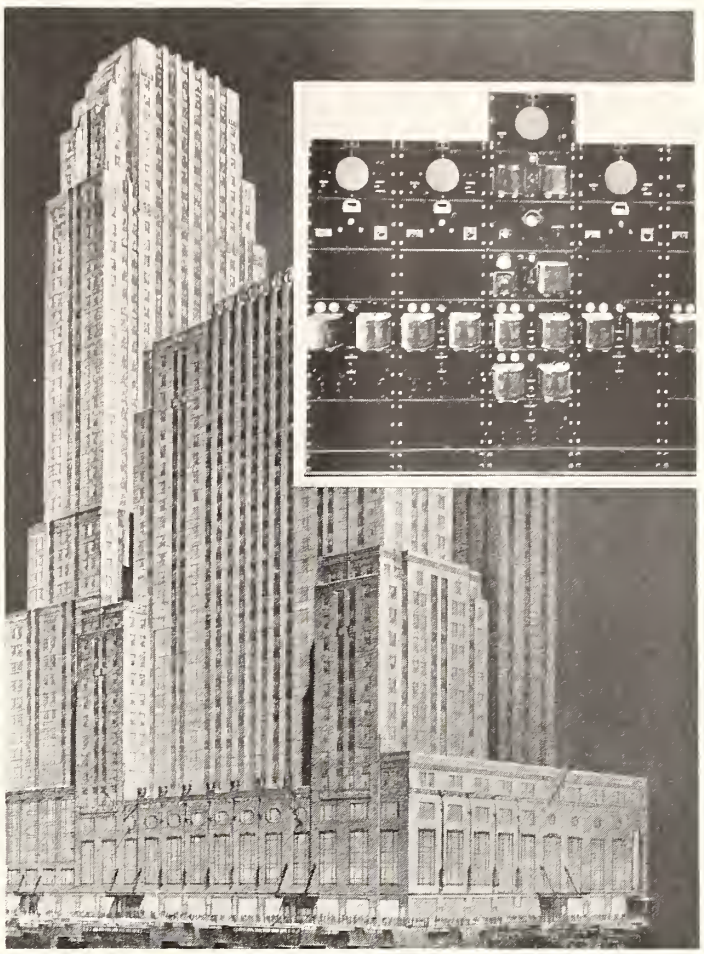
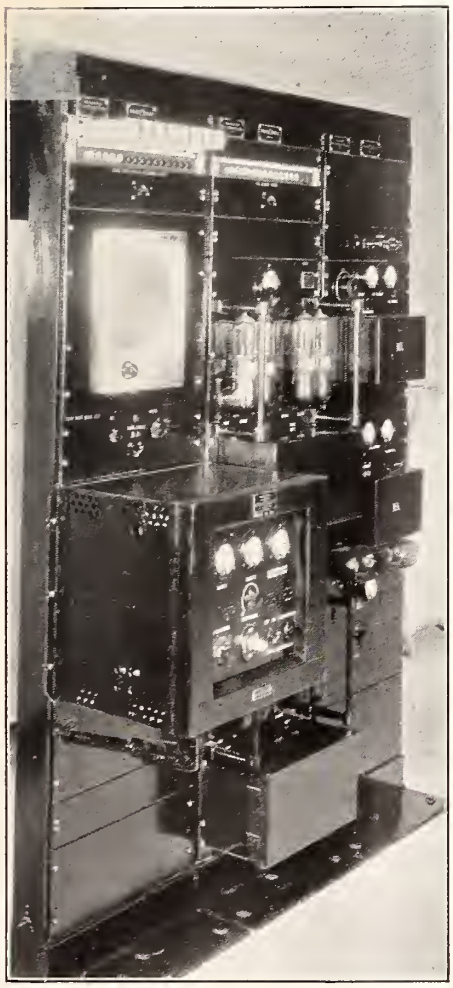
SOUND distribution engineers have seen the extension of public-address installations increase two hundred per cent within the past eighteen months. The manufacturers of systems, units and accessories have kept pace with the demands for service and there are now available comprehensive lines of apparatus.



Insert shows panels of sound distribution system designed for hotel use.



Power equipment for public address system in the Earl Carroll theatre, New York. (Western Electric.)

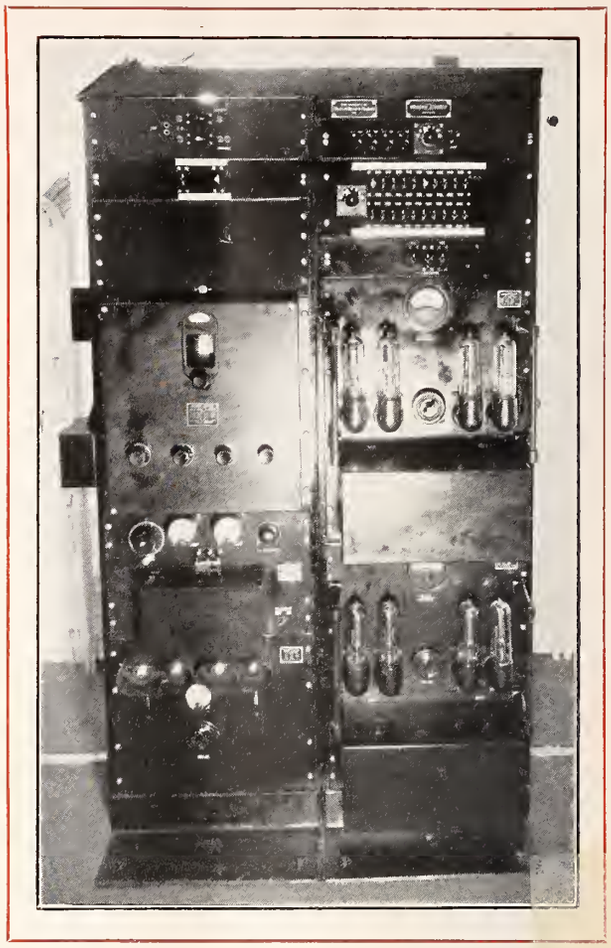
From the largest hotel or stadium installations down to the smallest and lightest portable units standard equipment of matched design is available.

During the past year or two, terms have come into use by means of which sound engineers are enabled to talk and write intelligibly on the general subject of public address. Some of these terms are: Rack amplifier, sound truck, portable address system, amplifier unit, microphone amplifier, junior portable address system, bowl type speaker, wall speaker, speaker chassis, sound-on-film amplifier with P. E. cell, etc.

There are several well established companies now engaged in manufacturing and installing public-address systems. While the equipment used in public-address installations is similar in certain respects to the equipment comprising the "sound" half of sound-picture theatre systems, public-address requirements cover a wider range of amplifiers, panel boards and reproducing loudspeakers. In fact the type of apparatus to be installed in a given application depends to a considerable extent upon the interior or exterior space to be served. Enough experience has now been gained relative to the needs in various circumstances so that almost any set of conditions involving space, area to be covered, volume desired, uses etc., may be met. Wide interest is being displayed in further unique applications of these systems.

Public address in football stadium.

Public-address system on new steamship

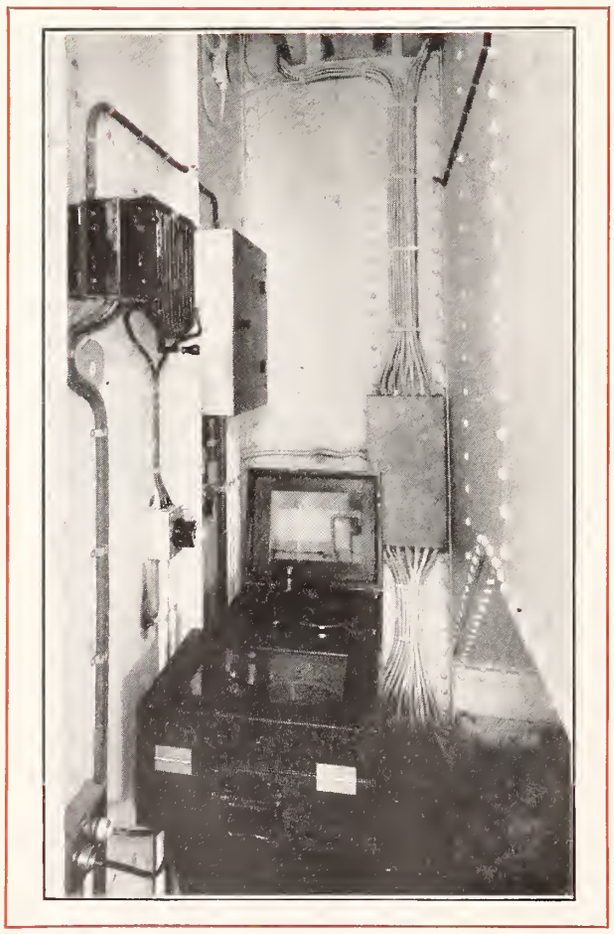


Now on its first trip around the world, the "S.S. President Coolidge" of the Dollar Line, 659 feet long and the largest ship built in the United States, is equipped with every modern convenience including a complete talking picture reproducing equipment and a public-address system for sound amplification.

The public-address system provides for the transmission of announcements from three locations, the chart house, the musicians' balcony in the first class dining room and the booth. Twelve permanent dynamic speakers are located in various lounges, the smoking and dining rooms, tea gardens and soda fountains.

The de luxe suites are equipped with loudspeakers having individual volume control. Thirty outlets for magnetic speakers are located in the staterooms and in the mess room on the promenade deck. A dynamic speaker outlet is provided on the game deck for the swimming pool.

The complexity of the job required special panels for controlling the speakers and for the connection of the various methods of reproduction to the distributing system and the stage horn. The problem was engineered by the special projects division of Electrical Research Products under A. McLean. Layouts and special panel designs were prepared by H. A. DePalma and F. W. Nickerson and the latter was in charge of the actual installation.



Above——

Main amplifier equipment as viewed through a porthole from main salon. The upper half of the left-hand section contains input switching facilities together with the radio broadcast receiver and associated rectifier. The three upper panels of the right-hand section contain the switching facilities for control and distribution of the sound picture program to the main salon, and program distribution to various public rooms and staterooms. The remaining panels contain the main amplifier equipment.

Left——

Projection room as viewed from a point opposite the entrance, showing non-synchronous reproducing equipment, sound control units and terminal wiring to loudspeaker distribution system.

A new portable, battery-operated, separate film sound recording system

By Verne T. Braman*

ALTHOUGH both the newsreel and the studio types of equipment have performed their intended work admirably, there has been a growing demand for a recording system to fill the gap between the two, combining the advantages of both systems. With this in mind, a new sound-film recording system has been developed which combines the portability of the newsreel system with a separate film recorder which allows separate treatment of the sound and picture negative, independent of the picture camera from recording attachments, and the use of more than one picture camera operated in synchronism if necessary.

A system of this type is suitable for practically any sound picture work, and can be used equally effectively for newsreels, industrials, educationals, and feature productions. The complete equipment can be carried in a small car, and can be used as well on location work as in a studio. The essential feature is that regardless of the type of work, the sound will always be of feature production quality, due to the fact that the essential units are basically of the same principle and design as those used in the best studio installations.

The first and most important step in making a portable double system was in the elimination of the use of alternating current, which either requires the use of an alternating-current generator or limits the use of the system to a vicinity where an a-c. power line is available. This was accomplished by the use of a novel type of direct-current motor sometimes known as d-c. interlock motor. These motors are constructed on the principle of a dynamotor, having the armature winding connected to a commutator in the usual manner, and also split into three sections which are connected to three slips rings. When these motors are in operation as d-c. motors, they also operate as alternating-current generators, and three-phase current is obtained from the three slip rings. If two such motors are in operation, and the three slip-ring brushes of one are connected in the proper phase relationship to those of the other, the two motors will immediately lock themselves into perfect synchronism. This is because the faster motor will act as a generator and tend to speed up the other, being in turn slowed down by the load. The motor with the tendency to be faster will supply just enough current to provide stability and keep the motors in synchronism.

If the speed of one motor is adjusted by means of a field rheostat to the desired value, the other motor will run at exactly the same speed because of the alternating currents produced. In fact, the d-c. armature leads may be entirely disconnected from one motor and it will still remain in synchronism, being operated through the interlock system as an a-c. synchronous motor.

Fig. 1 shows the complete system set up for operation. It is of course not necessary for the various units to remain in such close proximity, since cables are provided for remote operation and control. The camera drive motor shown plugs directly into a Bell & Howell, Mitchell, or Akeley audio camera, and can be adapted to practically any other type of camera that is silent enough for sound picture work. This motor has a speed of 1,440 r.p.m., and is of the interlock type described, being operated in synchronism with the recorder motor.

The recorder motor is provided with a field rheostat and tachometer for adjusting and observing the speed. Switches are provided so that the motors can be operated separately or in unison. These motors are extremely efficient. They are operable over a wide voltage range, and will run for a long period of time on heavy-duty radio "B" batteries.

The amplifier is of the latest design and, although small and portable, is rugged and efficient and performs as satisfactorily as the largest studio amplifiers. Meters are provided in all essential circuits for instant observation of circuit conditions, and a volume indicator is provided so that a visual as well as audible check on the volume of sound is to be had at all times. In spite of the compactness of the amplifier there is no cramping of the operator, and the two microphone inputs and mixers will take care of any portable requirements and practically all studio requirements. Additional microphone

*Vice-President, Blue Seal Sound Devices, Inc.

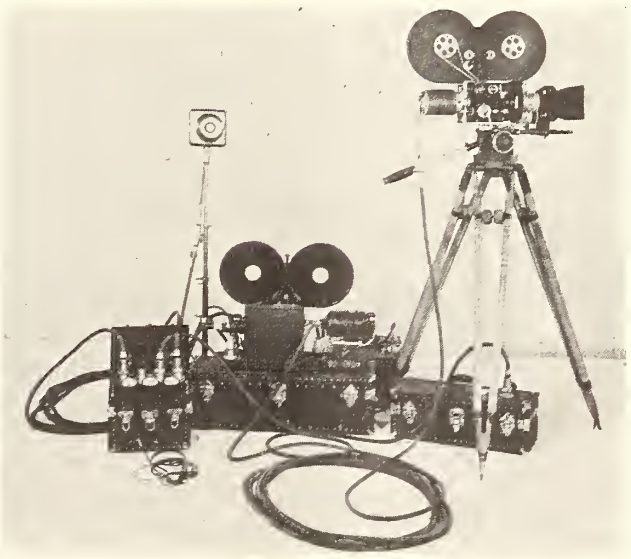


Fig. 1. Complete recording system set up for operation.

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Complete equipment for all-purpose recording on film may be transported in ordinary automobile.

mixers may be used externally if desired for intricate production work.

The Cineglow three-element recording lamp is employed in this system. This lamp was described for the first time in the January, 1931, issue of PROJECTION ENGINEERING, and subsequently in various other literature which pointed out its many advantages and unique ability to faithfully record sound. Since its introduction, this lamp has gained in popularity until it is now used throughout the world. Any one not acquainted with its operation is referred to the above mentioned issue of PROJECTION ENGINEERING.

The cases and cord connectors are rugged and durable, and the cable is of the super-service type, being shielded and covered with a tough rubber coating. All of the equipment is designed to withstand the most severe conditions and to give years of efficient and satisfactory service. The microphone is designed to operate either on a folding stand or from overhead suspension. A two-stage microphone amplifier can be provided if needed for long pickups and studio use. The microphones have been compensated to give a very good frequency response, especially for long pickups where the low frequencies usually predominate and cause tubbiness.

Fig. 2 shows the recording machine which is really the heart of any system. This machine is adapted from the studio recorder, and is a combination of simplicity and mechanical perfection. Each part is designed to efficiently perform its function, and there are no unnecessary parts or complications. In spite of its ruggedness as shown by its appearance, this machine is light in weight, being made of aluminum and hollowed out wherever possible. Two sprockets are provided, one to feed and take up the film, and the other to draw

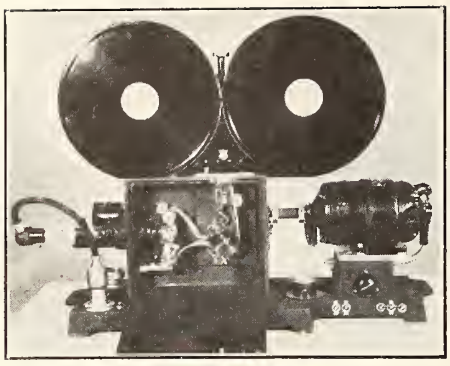

Fig. 2. Recording machine.

the film past the sound aperture. This latter sprocket is completely isolated from any irregularities in the gears, etc., by means of a mechanical filter. In addition to this, all sprockets, gears, bearings, and shafts are ground to the highest possible degree of precision, and all gears are completely enclosed. The sound aperture is of the curved block type with side tension provided so that the film always pulls itself in perfect contact with the aperture. The aperture as well as all the rollers, etc., is undercut so that nothing touches the film on the sound track portion. The illumination from the Cineglow recording lamp is focused by means of a condenser lens on to a slit in the lens barrel. This slit is in turn focused on to the film by means of an objective lens, which makes the slit image on the film extremely sharp. This entire lens assembly is prefocused at the factory and sealed into place, so that there is no focusing or adjusting to do by the operator, the lamp being merely inserted and locked into place. Due to the remarkable efficiency of the optical system and the three-element lamp, recording can be done directly on sound-recording positive stock, which is not only economical, but has a very fine grain, large volume range, and high resolving power.

The procedure in setting up and operating this equipment is very simple. The amplifier is connected by means of flexible cables to the battery box, microphone, and recording machine, and the motor battery is connected to the recording machine and the camera motor. The microphone is placed in position, either overhead or on the folding stand, depending on the subject matter, and the sound is monitored for both quality and level by means of the earphones and volume indicator. If two microphones are used, the proper balance is obtained by adjusting the microphone mixers until the required effect is obtained. When it is desired to "shoot," the motor switches are thrown on, which starts the recorder and camera in synchronism. This operation automatically lights the recording lamp, which prevents accidental failure to do so manually. The speed of the motors is indicated at all times by the tachometer, and can be adjusted at any time, although this is rarely necessary. If desired, either the sound recorder or picture camera can be run separately, and if silent inserts are desired, the camera motor and motor battery can be removed and used independently of the sound equipment.

With the many advantages of this new sound system, which includes the simplicity and portability of newsreel equipment combined with the flexibility and quality of recording of studio equipment, and with the added advantage of an inexpensive system adaptable to any good picture camera, there should be no reason for apologies for the quality of sound on the part of any producer, large or small, regardless of the subject matter or type of production.

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Projectionists progressing with studies

The series of technical examinations we are publishing monthly in PROJECTION ENGINEERING has attracted wide attention among the men who operate talking picture equipment in theatres.

Among the sets of answers submitted to the second ten questions we note that those who have turned in answers substantially correct are: Richard Fitz, New Brunswick, N. J.; W. N. Leamon, Marion, Ind.; Kirk Bucbak, Minneapolis, Minn.; Robert A. Passmore, Valdosta, Ga.; W. Hay, Calgary, Alberta; Albert Bolze, Glasgow, Nova Scotia; Frank Griesel, Regina Sask.; D. V. Cavan, Racine, Wis.; M. A. Park, Ashland, Ohio; A. A. Fagan, Albany, N. Y., and C. L. Merrell, Selma, Tenn.

These are in addition to the examinations reported on page 10, of PROJECTION ENGINEERING for November.

Eastman supersensitive motion picture negative film†

By Emery Huse and Gordon A. Chambers*

The advantages which the new supersensitive film has over the present type of film are described, and comparative photographic characteristics of the two types of film are presented. In addition, the paper includes a brief discussion of the particular features involved in the use of the faster film, such as the difference in color sensitivity of the two types, and relative contrast, and the rendering of details in shadows and soft highlights. Users of the new film are cautioned against the danger of processing it when using the present safe lights, on account of the greater speed of the emulsion. The paper concludes with a description of the gray base which has been provided, mainly for the purpose of avoiding halation.

As the name "supersensitive" implies, the new Eastman supersensitive panchromatic type 2 emulsion is extremely fast, but because of its name this new film must in no way be confused with a hypersensitized film. In the past when an emulsion of very high speed was desired for color photography, filter shots, or trick work, it was customary to especially treat the film in some kind of sensitizing bath. This bath caused a general increase of speed, and particularly increased the speed of its reaction toward red light. However, the sensitized film had certain disadvantages, such as its cost, its lack of keeping-qualities, and its propensity to produce fog. In the supersensitive type of emulsion these disadvantages are entirely overcome. The increased speed of the new film is obtained during the course of manufacture. It is sufficient to say, therefore, that the supersensitive film is not a hypersensitized film. Furthermore, it exhibits the same keeping-qualities, and shows identical physical characteristics to those shown by the present panchromatic films.

A complete study of any type of film emulsion is best accomplished by making both sensitometric and practical camera tests. This paper will not deal in any way with the camera tests, but will consider in some detail the sensitometric characteristics of the new emulsion as compared with the present panchromatic emulsion. The point of major importance in considering the new film is its greatly increased speed. The data obtained by sensitometric measurements can be, and have been, checked by camera exposures.

Sensitometry involves a study of known values of exposure as related to the amount of silver (density) which these exposures produce upon the film after development. The standard sensitometric curve is therefore one in which is shown the relationship between exposure (expressed logarithmically) and the densities produced. It is from curves of this type that the sensitometric characteristics of the films under investigation have been studied.

Another important point that must be considered is in relation to the quality of the light to which the film is exposed. For this reason sensitometric tests have been made exposing the film to daylight and to light emitted by a tungsten source. Inasmuch as the method of testing an emulsion when exposed to any kind of source of light is practically identical, we shall, for the sake of simplicity, consider only curves obtained on exposing the film to the light of a tungsten source.

Fig. 1 shows the sensitivity curves of the present and the supersensitive types of film, exposed to a tungsten source and developed for a fixed time of nine minutes in a standard borax developer. It will be observed that the curve for the supersensitive film lies above the curve for the present type of film, and that the separation between these curves is a measure of the difference of speed of the two films. In making a numerical estimate of the speed we do not consider the actual densities produced by given exposures; it is customary to deduce the speed from the exposure indicated by the point where the linear portions of the sensitivity curves produced intersect the exposure axis. Speed is usually defined by the following formula:

$$\frac{1}{i} \times C = \text{speed}$$

in which i, the inertia, is the exposure indicated by the point of intersection and C is an arbitrary constant. For the curves shown in Fig. 1 we find that

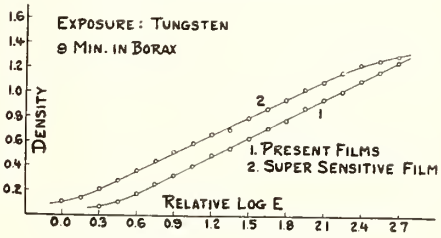

Fig. 1. Sensitivity curves of present film and supersensitive film.

the speed of the supersensitive film, as represented by curve No. 2, is three times that of the present type of film. Identical tests made with daylight exposures show that the supersensitive film has twice the speed of the present type. Attention should be called to the marked difference between the curves in the region of low exposure, that is, in the "toe" of the H & D curve. In this region the supersensitive film definitely differentiates between exposures of very low intensities. Particular reference is made to exposures less than that indicated by relative log E = 0.3.

The cause of the difference between the speeds of the two types of film when exposed to a tungsten source and to daylight, or to any other source, is entirely dependent upon the color distribution of the light emitted by the source, and its effect upon the emulsion as determined by the color sensitivity. It is generally known that tungsten sources, for example, radiate a greater proportion of red light than is found in daylight, and the difference between the speeds of the two films indicates that the supersensitive film must be more sensitive to red light than the present

†*Presented at the S. M. P. E. Spring, 1931, meeting at Hollywood, Calif.*

**West Coast Division, Motion Picture Film Department, Eastman Kodak Company.*

film. It is mainly for this reason that the ratio of the speeds of the two films is greater when exposed to the light of a tungsten source than when exposed to daylight.

The difference in color sensitivity of the two types of film is shown in Fig. 2. This illustration shows prints of spectrograms of the two types of film when exposed to the light of a tungsten source. Comparisons of speed should not be made from these prints as the prints have been so made as to show the regions of the spectrum in which each emulsion is sensitive. The numbers in Fig. 2 represent wavelengths; beginning at 0.40, in the blue-violet region, the wavelength increases through the blue-violet, blue, green, yellow, and orange as far as red, at a wavelength of 0.68 microns. The supersensitive film shows an increase of sensitivity around 0.64 microns. Its sensitivity drops abruptly at the long-wave limit of visibility, whereas the present type of film is quite sensitive to the deep red, and even encroaches upon the near infra-red. This is an important advantage as it is the sensitivity at the longer wavelengths that contributes to the production of chalky highlights when tungsten sources are used. This is eliminated to a marked degree in the supersensitive film.

A complete study of the color sensitivity of an emulsion requires the measurement of speed at the three major portions of the visible spectrum, namely, blue, green, and red. For the purpose of obtaining such information, speed curves similar to those shown in Fig. 1, later substantiated qualitatively by exposures made in a camera, were made, exposing the film to daylight through the No. 49 (blue), 58 (green), and 25 (red) filters. Such tests showed that the supersensitive film has 75 per cent

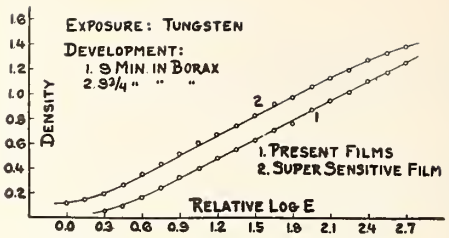

Fig. 3. Curve showing times of development required to produce the same gamma.

more speed when exposed to the blue, 200 per cent more when exposed to the green, and 400 to 500 per cent more speed when exposed to the red than the present film.

Another important thing to consider when comparing the two types of film relates to the contrast and to the rendering of details in the shadows and softer highlights. Fig. 3 shows, for exposures to tungsten sources, the difference between the times of development required to produce in the two types of film equal degrees of contrast (gamma). Both curves of Fig. 3 have the same gamma; the data show that it was necessary to develop the supersensitive film three-quarters of a minute longer to produce this effect. Furthermore, greater density is obtained in the low-exposure region, due mostly to the greater speed of the supersensitive emulsion. It is this ability to respond to and differentiate between these low intensities which gives to the supersensitive film its great capability of rendering details in the shadows. On the other hand, it will be observed that in the high-exposure region the curve of the supersensitive emulsion tends to bend toward the horizontal, whereas the curve of the present type of film continues as a straight line. This is at least true of the series of exposures shown in the illustration. This characteristic leads to a softer rendering of highlights and yet permits a very definite separation of highlights, providing good detail in this region.

Fig. 4 shows in more detail the relationship existing between the contrast (gamma) and the time of development. These curves, commonly referred to as time-gamma curves, show the rate at which the gamma increases with the time of development. The rate of increase of the gamma of the supersensitive film is appreciably less than that of the present type of film, as inspection of the curves of Fig. 4 will show. This means that there is much less chance of over-developing or under-developing the film during processing. Errors of the order of 25 per cent in the time of development will show much less effect on the supersensitive film than on the present film. In other words, the new film provides for a much greater "development latitude."

One important caution must be mentioned; due to the great sensitivity of the new emulsion, the film cannot be

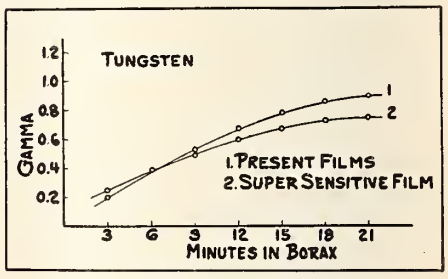

Fig. 4. Time-gamma curves of the two types of film.

successfully handled unless the light emanating from the present safelights is considerably reduced. It would be best to handle the film in total darkness; no doubt this will be done, inasmuch as many camera loading rooms and laboratories where negative film is processed in machines are kept quite dark, if not totally so. It is felt, therefore, that this requirement will not cause any great hardship; however, this word of caution is considered necessary on account of the greatly increased speed of the new film with regard to both white and colored light.

Gray Base Film

Since the introduction of the supersensitive negative another decided improvement has been made which will generally enhance photographic quality. The emulsion is now coated on a gray base, mainly for the purpose of preventing halation. The gray base was introduced to the motion picture industry in May, 1931.

Halation has always been a source of trouble for photographers. The halation which appears as a glow encircling the highlights of the picture is due to the reflection by the rear surface of the film base of the light which has passed through the emulsion and the support,

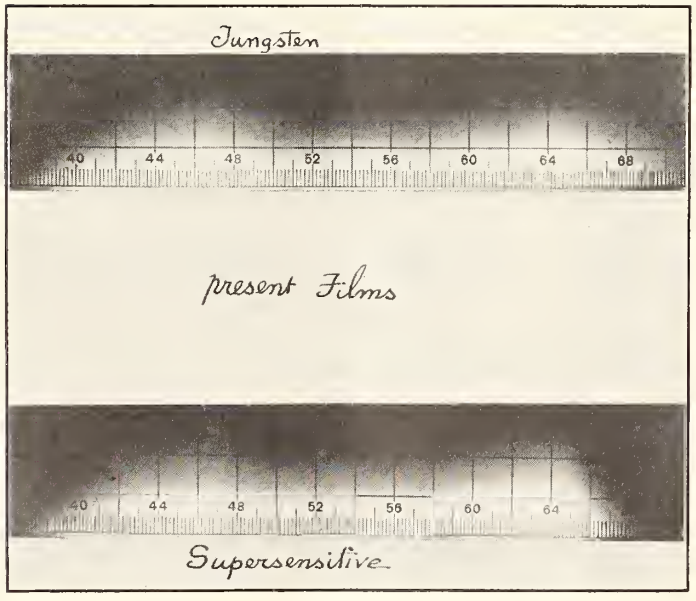

Fig. 2. Spectrograms of the two types of film, obtained by exposing to the light of a tungsten source.

so that it becomes incident upon the sensitive surface a second time, this time from the rear. In the case of glass plates where the thickness of the emulsion support is appreciable, halation is very serious, while in the case of the thin film base the effect is so reduced that in ordinary photography it is negligible. Indeed, one of the advantages that has always been claimed for film, as compared with plates, is the great freedom from halation which the former provides.

The importance of halation, however, is a relative matter. A spreading of light which is utterly negligible in an 8 x 10 picture may be serious in a smaller picture, and very serious indeed in a motion picture frame. For this reason negative film has for years been made with a double coating of emulsion, so that in addition to other benefits conferred by this procedure, halation is reduced to a minimum. When working with glass plates photographers have been accustomed to reduce the halation by coating the backs of plates with a "backing" which prevented the reflection of light from the rear surface of the glass and which could be removed during or after development. "Backing" is a messy operation and the dissolving of the backing in the developer is not at all desirable, but its effect in diminishing halation has led to a wide use of this method.

In the motion picture industry it has not seemed desirable to place a soluble backing on negative film, but fortunately the same result can be obtained in another way. For many years the Research Laboratories of the Eastman Kodak Company have been experimenting with backings, as a result of which they have evolved a special light gray backing which can be applied to negative film and which, in conjunction with the double coating, obviates halation

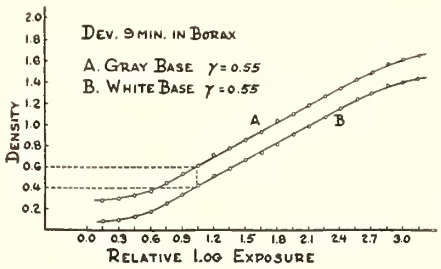

Fig. 5. Curves of white and gray base films.

completely. This gray base does not change during processing and so involves no danger of chemical trouble.

It is of importance to note that anti-halation backings have no direct chemical effect upon the emulsion characteristics. However, a decided improvement of photographic quality is effected by avoiding the scattering of light by the base side of the film. The absence of scattering provided an *apparent* change in the characteristics of the emulsion, although this effect is reached indirectly and not as an actual alteration of the emulsion.

Results obtained by making motion pictures with the new film show a marked improvement in sharpness, detail in the highlights, and an over-all improvement of photographic quality. The effects of halation are far-reaching, and a film which avoids these effects should be of the utmost value to the cameraman.

Discussion

Mr. Mole: May not the present film be used for making night shots in the daytime, where light green fields are often encountered as a background? The regular panchromatic film required a great deal of care when making night shots during the daytime due to the fact that there was a tendency for the green to show white. I wonder if in this more sensitive type of negative such a condition might not be corrected?

Mr. Huse: I believe that a great deal of "over-correction" is in reality under-exposure. The old type of film was not sufficiently fast, particularly in the red, where you needed the speed most when making night shots in the daytime, using deep red filters. But the new film has sufficient speed to permit most satisfactory work of this kind. It is possible to get a much better timed exposure and to do away with any sharp contrast which might appear to be over-correction and which in reality is partial over-correction combined with under-exposure.

Mr. Palmer: Will you explain the physical difference between non-halation film and ordinary film?

Mr. Huse: Non-halation film contains a neutral gray dye which prevents halation. This will cause an increase of about 1 to 1½ printer points in printing; otherwise, there is no change required in the composition nor are any other difficulties found in printing through it. This film was presented to a group of camera and laboratory men last week and all the laboratory men present thought that this feature would not introduce any difficulties whatsoever.

Mr. Kains: Is any special handling of this super-speed film required for use in the tropics?

Mr. Huse: No more precaution is necessary in using the supersensitive film than in using any other type of film. Any type of film will deteriorate under high temperature and high humidity and the physical characteristics of this film are identical to those of any panchromatic film. As a matter of fact, our films are being shot in the tropics, and I heard only the other day that we had some films sent back to us from Europe which were shot in the tropics not more than a month ago.

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SOME ASPECTS OF A MODERN SOUND RECORDING SYSTEM

(*Concluded from page* 15)

pendable. There are no ribbons to replace and tune; it will not break down on percussion sounds as ribbon valves sometimes do and it is not affected by temperature. The frequency characteristics of recording lamps are inherently superior to the mechanical type owing to less attenuation of the higher frequencies and complete absence of second and third harmonics.

Operation of the lamp is extremely simple. Exposure is regulated by the current flowing through the lamp. Light from the lamp passes through a quartz slit .8 mil wide which is in contact with the film. The slit is mounted in the end of the lamp holder which is equipped with micrometer adjustments.

Focussing the light from the recording lamp upon the film by an optical system was discarded because of the distortion produced by the lens with attendant loss of light. To overcome the loss introduced by the lens the recording lamp must be worked at a higher brilliancy resulting in short life. Needless to say, frequent replacement of recording lamps runs up the operating costs. Fortunately, in the interests of quality and economy the direct slit is superior. With a little care the quartz slit will last indefinitely.

The lamp will handle a level of plus 12 db. without overloading. An impedance matching network is interposed between output of amplifier and recording lamp.

This up-to-date, dependable equipment is manufactured by the Canaday Recording Equipment Co., 714 Leader Bldg., Cleveland, Ohio.

QUESTIONS NOS. 21 TO 25

21. What is a condenser? (a) optical? (b) electrical? (c) chemical?

22. Do the Western Electric and RCA Photophone both employ amplifiers on the projector? If not, how is the energy from the photoelectric cell amplified?

23. What is the difference between a starting box and a speed regulator?

24. What current is required for a 2,000 c.p. arc lamp?

25. Why is the Edison three-wire system economical of copper?

The calculation of supply voltage, and load impedance for a vacuum tube

By E. K. Brown*

WHILE investigating the characteristics of vacuum tube loads from the Ep-Ip curves it occurred to the writer that it should be possible to derive by mathematical analysis an expression which would give the value of load impedance and necessary supply voltage to be used under any given values of grid swing and requisite plate voltage. The final result was a simple formula which the writer has not seen previously published, and which, on account of this simplicity and its adaptability to other conditions, it is considered might be of interest.

It will be noted that expressions are developed for two cases, i. e., a load impedance equal to the tube impedance and a load impedance equal to double the tube impedance, but the expressions can be easily extended to include load impedances having any given relation to the tube impedance.

The result of the analysis and its application suggest some limits to grid swing apart from considerations of a positive grid, and of this it is hoped to treat in a future paper.

The plate current (Ip) in a tube is a function of the grid voltage (Eg) and the plate voltage (Ep).

*Western Electric Company (NZ) Ltd., Auckland, N. Z.

$$Ip = f(Ep,Eg) \qquad (1)$$

The impedance (Zp) of a tube working as an amplifier may be taken, to a sufficient approximation,[1] as the reciprocal of the slope of the Ip-Ep characteristic or,

$$Zp = \frac{1}{f'(Ep,Eg)} \qquad (2)$$

To secure maximum power output from a tube it can be shown that the load impedance (Z_L) must be equal to the tube impedance (Zp). Now the slope of a load line on the Ip-Ep graph is the reciprocal of the impedance, or:

$$\frac{1}{Z_L} = \frac{d\,Ip}{d\,Ep}, \qquad (3)$$

For maximum power output then from a tube the slope of the load line through the working point on the Ip-Ep curve must equal the slope of the Ip-Ep curve at that point, or,

$$\frac{1}{Z_L} = \frac{d\,Ip}{d\,Ep} = \frac{1}{Zp} = f'(Ep,Eg) \qquad (4)$$

The load line intersects the x axis at the point of supply voltage (Es) and therefore,

$$\frac{d\,Ip}{d\,Ep} = \frac{Ip}{Ep-Es} \qquad (5)$$

It will be noted that this slope is negative, indicating its direction, but since this point is of no concern in what follows we shall use the absolute value only, or:

$$\frac{d\,Ip}{d\,Ep} = \left|\frac{Ip}{Ep-Es}\right| = \frac{Ip}{Es-Ep} \qquad (5A)$$

substituting in (4)

$$f'(Ep,Eg) = \frac{Ip}{Es-Ep} \qquad (6)$$

$$Ip = f'(Ep,Eg).(Es-Ep) \qquad (6A)$$

Van der Bijl[1] gives the equation for Ip,

$$Ip = a(Ep + \mu\,Eg + \varepsilon)^2 \qquad (7)$$

As pointed out by Van der Bijl, this equation, while not strictly true,[2] is sufficiently accurate for practical purposes. (6A) then becomes,

$$Ip = a(Ep + \mu\,Eg + \varepsilon)^2 = \frac{d}{d\,Ep}[a(Ep + \mu\,Eg + \varepsilon)^2](Es-Ep). \qquad (8)$$

or, neglecting the small quantity ε,

$$a(Ep + \mu\,Eg) = 2a(Ep + \mu\,Eg).(Es-Ep) \qquad (8A)$$

which can be written,

$$Es = \frac{3\,Ep + \mu\,Eg}{2} \qquad (9)$$

where μ = amplification factor.

It can be easily shown that the actual amplification constant (μ) of a tube is related to the maximum amplification constant (μ_m) by the relation

$$\mu = \frac{Z_L}{Zp + Z_L}\,\mu_m \qquad (10)$$

Thus the higher the load impedance the more nearly the actual amplification factor (μ) approaches the theoretical or maximum amplification (μ_m).

The expression (9) gives the value of supply voltage necessary to secure any given plate voltage on a tube at a given value of Eg when connected into a load equal in impedance to that of the tube.

As an example of the application of this equation take the curves given in Fig. (1) for a Western Electric 205-D tube. Assume it is desired to work the tube at a plate voltage of 300 v. and as a peak grid swing will not exceed, say 25 volts, allow —25 v. grid bias. This

[1] "Thermionic Vacuum Tube," Van Der Bijl, p. 151, p. 165.

[2] Equation (9) is strictly true only for that part of the characteristic curve over which $(Ip)^{1/2} = (Eg + \mu Eg)$ is a straight line.

▲

Starting with the functional expression for the plate current a relation is developed between the expressions for tube impedance and load impedance when these are equal, and this relation is developed into an expression giving the value of supply voltage necessary under these conditions. The value of the impedance is found and an example of the application of the expression given. . . . The expression is further developed to include the case of a load impedance double the value of the tube impedance, and an example of its application given.

from the curve gives a plate current Ip of 16 ma.

From the family of curves it will be seen that the amplification factor (μ_m) of this tube is approximately seven. Since we are using a load impedance equal to the tube impedance, (10) can be written.

$$\mu = \tfrac{1}{2}\,\mu_m = 3.5$$

using (9)

$$Es = \frac{3\ Ep + \mu\ Eg}{2} \qquad (9)$$

$$= \frac{900 - 88}{2} = 406v.$$

Through the points Ep = 300v, Eg = —25v, and Es = 406v, draw the load line cutting the Eg = Ov curve at Ep = 193v, and the Eg = —50v (the limits of assumed swing), at Ep = 385v. The plate voltage swing is thus 192v. The impedance of the load can now be obtained from (5A).

$$\frac{1}{Z_L} = \frac{Ip}{Es\text{-}Ep} = \frac{.016}{106};\ Z_L = 6600\omega \qquad (10)$$

The amplification factor is actually 3.8, which is in fairly close agreement with the estimated value 3.5.

The plate impedance at the point Eg = Ov, Ep = 193v is approximately 3,000 ohms and at the point Eg = —50v, Ep = 385v is approximately 9,900 ohms, the calculated value 6,600 ohms is therefore a mean value.

It is desirable, however, for the purposes of lessening harmonic distortion, to make the load impedance double that of the tube since, while this lessens the output but slightly, it has a relatively great effect on the elimination of the harmonic content.

Correction can be easily made for this from the above by allowing a sufficient increase in Es, to account for the drop in the extra impedance.

In the present case let it be desired that the load impedance be double that of the tube. From (3) and (5),

$$Z_L = \frac{Es - Ep}{Ip} \qquad (11)$$

and the potential drop (E_L) over this is

$$E_L = Z_L Ip = E_s - Ep \qquad (12)$$

The total supply voltage (E_{rs}) required is then the sum of (9) and (10).

$$Ers = \frac{3\ Ep + \mu\ Eg}{2} + (Es - Ep) \qquad (13)$$

which may be written

$$Ers = 2\ Ep + \mu\ Eg \qquad (13A)$$

and the load impedance (Z_{L2}) in this case is

$$Z_{L2} = \frac{Ers - Ep}{Ip} \qquad (14)$$

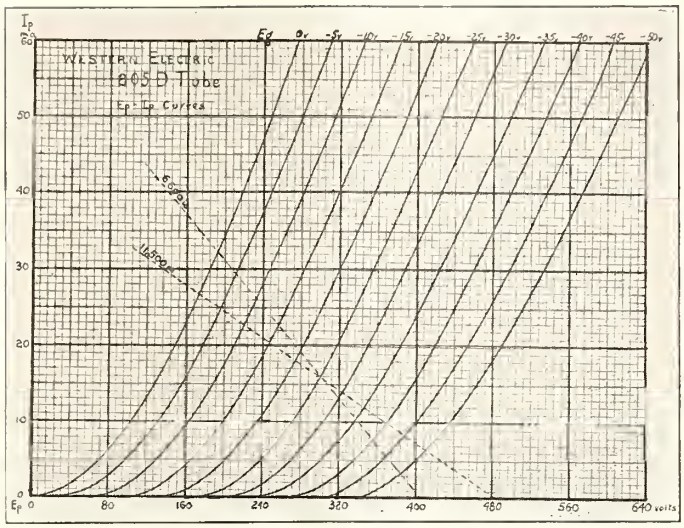

Fig 1. Functional characteristics of the 205-D tubes.

Assume the same values as in examples 1, i. e., Ep = 300v. Eg = —25v.

The amplification constant (μ) is now from (10).

$$\mu = \frac{2}{3}\,\mu_m = 4.6 \qquad (15)$$

and the supply voltage Ers,

$$\begin{aligned} Ers &= 2\ Ep + \mu\ Eg \\ &= 600 - 115 \\ &= 485v. \end{aligned} \qquad (16)$$

The impedance,

$$Z_{L2} = \frac{208}{0.025} = 11{,}500w \qquad (17)$$

Draw the new load line through the points Ep = 300v, Eg = —25v, and Es = 485v. The Ip-Ep curve, Eg = Ov is now cut at Ep = 176v. and the Eg = — 50v. curve at Ep = 412v.

The plate voltage swing is thus 236v, the increase being due, of course, to the increased amplification constant with increased load.

The amplification is thus 4.7.

The impedance at Eg = Ov, Ep = 176v is approximately 3,200 ohms and at Eg = —50v, Ep = 412v is approximately 7,600 ohms. (18)

Double these values are 6,400 ohms and 15,200 ohms, respectively, so that the calculated value of impedance lies closely enough to a mean between these two values.

It is interesting to note the variation in output power and in harmonic content by the increase in load impedance.

In the case of the 6,600 ohm load we have for the output power (P_1).

$$P_1 = \frac{Ip\ max - min.\ Ep\ max - min.}{8}$$

$$= \frac{29.25 \times 192}{8} = 703\ \text{milliwatts} \qquad (19)$$

and harmonic content,

$$H_1 = \frac{\tfrac{1}{2}(Ip\ max + Ip\ min) - Ipo}{Ip\ max - Ip\ min.} = .055 = 5.5\% \qquad (20)$$

In the case of Z_{L2} = 11,500 ohms we have

$$P_2 = \frac{20.35 \times 236}{8} = 600\ \text{milliwatts} \qquad (21)$$

$$H_2 = \frac{.575}{20.35} = .0283 = 2.83\% \qquad (22)$$

Thus, while the power is decreased only 14.6% of the maximum, the harmonic content is decreased by 48.5%. This power loss corresponds to a change of less than 2 db, an amount hardly appreciable to the ear.

▲

THE SKATING RINK MUSIC PROBLEM

(*Concluded from page* 12)

the manufacturer who would employ a band—it need not be a large one or a high-priced one—but one which would play and record all the new hits and the old favorites in a manner that intended for skating only. That is, all of the music to have a beat of 56 per minute and this tempo emphasized, so that a dozen or two of these records could be played automatically and all have the proper cadence. Rinks would begin installing sound equipment immediately and they and the many who already have equipment would be each an outlet for six to twelve or even more records a week.

If the manufacturers of calliopes and mechanical music boxes can go to the expense of manufacturing paper rolls for skating only, it is reasonable to assume that the market would be even better for records made for this purpose, for the days of the calliope and the music box are over. The era of electrical sound equipment is here to stay.

Installation of "sound" in Great Britain

By Bernard Brown

When "sound" was introduced precipitately in theatres in the British Isles many difficulties were experienced. The present article tells how these were overcome.

FIGURES have been published showing the progress of installation in Great Britain, but little has been said so far of the difficulties encountered. It is sometimes thought that owing to the smallness of many of the cinema halls installation was a relatively simple matter, but unfortunately this argument was by no means universally true, and so a few notes on the subject may prove of interest to American projectionists.

The rush for wiring started, of course, with the presentation of "The Singing Fool," although "The Jazz Singer" was the first feature film to be screened in London. Most of the early installation work was done by the Western Electric Company and RCA-Photophone, Inc., although British Talking Pictures and British Acoustics also were active. By far the greatest proportion of cinemas were wired by the Western Electric Co., which still holds the majority. The first difficulty to be tackled by the companies was the lack of trained men. There were plenty of radio engineers available, but talking pictures were naturally foreign to them and furthermore they were not acquainted with cinema projection and theatre conditions generally. In face of this difficulty the Western Electric Co. opened installation schools in London and gave their engineers a two weeks' intensive course on the principles of talking picture apparatus and installation. To cater for the operating side of the business a number of projectionists were employed to erect the universal bases and run the show for a week after the opening date. The newly fledged British sound engineers were in the first place controlled by what was known as the "Flying Squad" from America, which did not leave the country until installation had been placed upon a sound basis.

Early days of installation were hectic, indeed. No one really understood the new apparatus and supplies were always badly in arrears. Unfortunately, too, the question of power supply greatly complicated matters and straightforward transformer jobs were the exception rather than the rule.

As is fairly well known, in Great Britain there are literally scores of different types of power supplies to be found within a mile or so of each other. The standard imported equipment required 110 volts a-c. at between 50 and 60 cycles. For some reason or other no d-c. equipment was introduced into the country. Probably this was just as well as otherwise great confusion would almost certainly have resulted.

Some of the earliest theatres to be installed obtained their converted supply by means of rotary converters, but these machines were not found entirely satisfactory and were soon abandoned, their place being taken by the regulation motor-generators. In all cases where rotary conversion plant was employed dual sets were installed so as to insure freedom from breakdown. Besides machines for supplying the alternating current, battery chargers also were required. Of course, if the supply to the theatre was of the correct frequency a type of valve charger was sufficient. In other instances, however, a small 30-volt motor-generator had to be fitted.

Undoubtedly the greatest trouble was caused by power supplies of a-c. where the frequency was outside the limits previously mentioned. In these cases twin sets of converters had to be fitted which, together with the battery charger, gave a total of ten machines, which were a weighty proposition and occupied much space, not always to be found easily. It was usually possible even in the smallest cinema to clear a room providing adequate space for the installation of conversion gear. Unfortunately, however, this did not necessarily solve the problem. In the first place, it was almost certain that the available floor space would be some considerable distance from the operating room, thereby complicating the wire runs. Again, if the conversion room-to-be was not on the ground floor the local building authorities had something to say on the question of floor loading. This usually meant ripping up the floor and fitting in girders and concrete. In the ordinary course of events this would be an unpleasant task, but it was rendered even more so when the whole job had to be completed within five or six days. Another annoying feature of rooms chosen for conversion plant was that few of them provided sufficient wall space for reasonable placement of the starting and control gear, which in those days was fitted in the conversion room itself and not in the operating room as insisted upon at a later date. Ten machines with their accompanying starters, meters, and shunts require very careful laying out if the completed job is to look presentable and not be a mass of twisted conduits.

The battery room was another source of trouble, although more illusory than real. It was required that the battery room be situated within forty conduit feet of the operating room. It usually took a great deal of searching to find the necessary space, and even when this was obtained the battery charger had to be located at a much greater distance. In such cases it was usually arranged for the shunt control of the charger together with the automatic make and break, to be fitted in the battery room, while the starter, etc., were fitted near to the charger itself. Much trouble over this might have been avoided had engineers troubled to work out the possible voltage drop which was really infinitesimal. In many cases the exhibitor was compelled to build small cubicles in the auditorium itself. It was quite common to see one of these at each side of the circle. In one would be housed the batteries, and in the other the non-synchronous turntables, and during opening week some trouble would be experienced in keeping away curious patrons.

Most of the later-built British cinemas had the screen within a foot or so of the back wall of the auditorium, thus leaving no room for the large exponential horns. There were only two ways out of the difficulty: either to bring the proscenium arch forward or recess the back wall. The latter was generally the method chosen, but even this was not

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The finest sound installation is made better with a Forest Rectifier. There is a Forest Rectifier for every type of sound installation.

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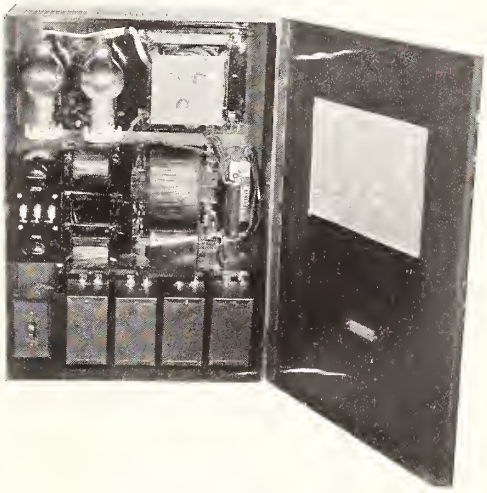

MODEL 77, INSIDE VIEW

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These past several months have seen marked improvement in the design of sound systems to meet the many new applications in which they have been employed. It is only fitting that RACON, being the foremost manufacturer of air-column speakers and dynamic units should be the first speaker manufacturer to announce new developments of outstanding merit.

RACON introduces 5 entirely new types of electro-dynamic speaker units. More powerful than earlier types, these RACON UNITS allow a wider frequency response, particularly on high frequencies. They further increase the high degree of natural tone so characteristic of all RACON AIR-COLUMN HORN SPEAKERS AND DYNAMIC UNITS.

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NEW "SUPER GIANT"

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SPEAKER UNITS

always practicable or allowable, depending upon local legislation. Another curious feature was that many exhibitors, while having no real stage room, insisted upon retaining the potentiality of using the few square feet in their possession. While it is fairly easy to construct horn towers to fit on to a small stage, it is an entirely different matter to arrange for their withdrawal when no offstage room is available.

Sometimes the question of actually getting the horns within the auditorium was itself more than a small problem. In several cases, in the experience of the present writer, walls had to be cut away owing to the fact that even the double-doored exits were too small. Sometimes, too, it was impossible to reach the stage when the screen was in position. Thus, during one night the old screen had to be removed, the horns slung in position and then the new Transvox erected and laced. This was especially difficult when local regulations demanded that the screen frame should be of metal construction.

In one particular case the writer remembers where the backstage room was so limited that it was found impossible to flare and tilt the horns correctly when in their logical position. To overcome the difficulty they were therefore inverted, but the end did not by any means justify the attempt. Although theoretically the sound axis is known to be 15 degrees divergent from the geometric axis, yet in practice other factors have to be considered. With these horns upside down, a thin but definite beam of scratch raked the circle which, of course, included the best seats. Illusion also was inclined to be poor except in the stalls. The introduction of the Roxy type of horn did much to alleviate the difficulty of horn placement in the smaller theatres.

British operating "boxes" were always proverbially inadequate and frequently the installation of sound equipment compelled complete rebuilding. Even when this was not undertaken, quite often concrete bases had to be prepared for carrying the bulky projectors. Such instances were particularly unfortunate for the installation engineer as changeover had to take place in one night. It was obviously out of the question to build up the new machines at the side, since it was impossible then to lift them on to the newly prepared bases of concrete.

Owing to restricted space in small theatres the amplifier rack could rarely be situated where it would be in plain view of both projectionists. Then again it was a fairly frequent occurrence for a large girder to strike right across the "box," usually just in the position where one wished to fix the monitor.

Acoustic faults were not so prevalent as might have been thought. The old style music halls, many of which had been converted into cinemas, were particularly happily placed as regards quality of reproduction. The ornate ornamentation and heavy hangings did much to keep the time of reverberation within the required limits. Some of these small, and by no means clean, converted music halls in the early days obtained reputation for clarity of speech which greatly increased their turnover. The writer remembers a case in the north of England where two cinemas were owned by the same person. One of these was a dirty little music hall, and the other a provincial super seating about 2,500. Naturally the owner was by no means pleased after both of these had been equipped that reproduction was very much better in his smaller hall. Engineers tried unsuccessfully for some time to raise the quality level of the super to that of the music hall. Needless to say, it was quite out of the question.

▲ ▲ ▲

New talking movies

THE measurement of the flickering of the eye in adding a column of figures, the analysis by the motion picture camera of wild oat seeds jumping along the ground like animals, and the recording of the daily work of school children learning to read by modern methods were among the subjects discussed recently by Frederick L. Devereux, general manager, Electrical Research Products, Inc., in his address, "The New Talking Movie," at the meeting of the Science Forum of the New York Electrical Society.

The address was illustrated by several educational talking pictures of the new type, among which were "Individual Differences in Arithmetic," by Dr. Guy T. Buswell, University of Chicago; "The Teaching of Reading," by Dr. Arthur I. Gates, Columbia University; "The Brass Choir," describing the use of brass instruments in a symphony orchestra; "Seed Dispersal," showing how nature distributes seeds; "The Modern Knight," showing the use of up-to-date communication devices in apprehending criminals, and others.

"It has been clearly demonstrated by carefully controlled experimentation that the talking movie is making a fundamental contribution to education," said Colonel Devereux, "not only in the field of teacher training, but also in actual classroom teaching situations. The new talking movie, however, to be of greatest service to education, must be produced along new lines that are in conformity with changing techniques in the teaching profession. Any program that is laid out for the production of talking movie subjects for educational use must be based on a program of research to determine the proper subjects to make and the materials to be included in those subjects. It must also include a series of tests and measurements to evaluate the subject matter used and its effectiveness in the enrichment of the school curriculum.

"The adaptation of the talking movie to industry promises to bring to the public economic and cultural benefits of ever increasing value. Here is a comparatively new medium that records and transmits ideas, locale and personalities to this and future generations, with a fidelity to truth and simplicity of operation that have earned it a high place in the history of the art of communication. It is a medium that makes use of all of the well-known devices of the silent motion picture—microscopic, diagrammatic, time-lapse, slow motion and realistic photography, and of the sound transmission principles of the telephone, the radio, and the phonograph, combining them all so skilfully into an harmonious whole that the illusion of reality is substantially maintained.

"Realizing the potentialities of the talking picture, many large industries have carried on progressive talking movie programs this year with excellent results. These programs have taken the form of pictures for employee training, sales demonstrations to dealer conventions, analysis of service faults and their correction, and straight sales messages.

"It is not expected that the talking movie will in any way supplant the classroom teacher. As a matter of fact, talking movies properly used will enrich teacher training courses and improve the quality of teaching by bringing to the aid of the teacher materials, information and demonstration otherwise not available."

Colonel Devereux described the procedures that were followed in the production of the pictures shown and outlined many of the problems that are being solved at the present time in technical research, appraisal research and curriculum research necessary in the developing of educational and industrial talking movie programs.

New Developments and News of the Industry

HIGH INTENSITY LAMPS

The U. S. Navy has placed orders for a number of Strong high intensity reflector arc lamps to be delivered to the Naval Academy at Annapolis and also to the Canal Zone, according to an announcement by the manufacturers, The Strong Electric Corporation of Toledo, Ohio.

Fort Benning, Ga., and West Point are points of delivery for Strong Hy-Lows, the U. S. Army placing the order. Other recent shipments included low intensity lamps for installation aboard the new Canadian Pacific Steamship Liners, Empress of Japan, and Empress of Britain, point of delivery being Glasgow, Scotland.

▲

LYRIC, NEW YORK, HAS NEW INSTALLATION

RCA-Photophone engineers are installing one of the new all a-c. operated standard size sound reproducing units in the Lyric Theatre on West Forty-second Street, New York. As soon as the installation has been completed, the house will be re-opened as a combination vaudeville and sound picture theatre.

▲

HARRY W. ACTON FORMS NEW COMPANY

An announcement of importance to the trade is made by Harry W. Acton, for many years general manager of the Brilliantone Steel Needle Company, selling agency of the W. H. Bagshaw Company. Mr. Acton has formed a new manufacturing company, which will be known as The H. W. Acton Co., Inc., with offices at 370 Seventh Avenue, New York City, and manufacturing plant at Providence, R. I.

The new company will, it is understood, continue to act as the sole agent of Bagshaw for the well-known Brilliantone needles, and Mr. Acton, in a personal interview, expressed his desire that the entire trade be informed of this continued relationship.

"The same faithful service which I have given those fellows in the years they have known me with Brilliantone, can still be expected of the new company," explained Mr. Acton. "While we intend to manufacture the general and special requirements of the trade under different brand names, the old relationship with buyers whose demand for Brilliantone products is established, will in no way be weakened or harmed."

▲

NEW HIGH INTENSITY LAMP

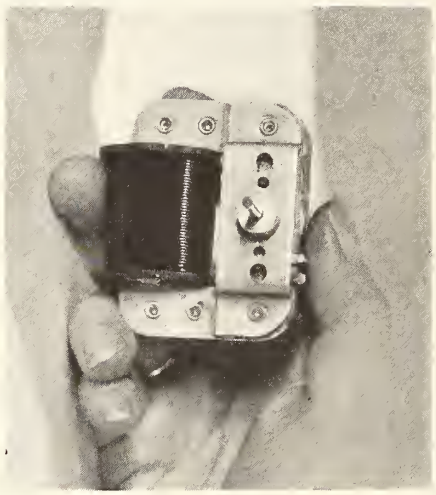
Hall & Connolly, Inc., have developed a new and radically different high-intensity projection lamp for amperages from 75 to 200 amperes. There are a number of new principles that will appreciably improve projection and facilitate operation.

Regular announcement will be made and complete description furnished within a few weeks.

SMALL SIZE, HIGH STARTING TORQUE, AMPLE POWER COMBINED IN NEW A-C. MOTOR

A new fractional-horsepower electric motor, no larger than the palm of one's hand, and with unusually high power output for its size, is now available for commercial use, according to an announcement recently made by Barber-Colman Company of Rockford, Illinois. The motor is furnished for either unidirectional or electrically reversible rotation, and is made for any voltage between 10 and 230, and for alternating-current frequencies from 25 to 60 cycles. Special two-speed models of the motor can be furnished.

The motor is ruggedly constructed of steel laminations, brass bearing plates with oilless bearings, and a squirrelcage rotor



upon a hardened shaft. All coils are wound on phenolic resin spools and impregnated to exclude moisture and insure good insulation.

Characteristics and advantages of the Barcol motor include small size with relatively high power output, quiet operation, and absence of interference to radio reception. The motors are used in modern electric fans, heat regulators, moving picture projectors, unit heaters, and numerous other applications where high starting torque and small size are an ideal combination.

▲

NEW AUXILIARY LENS SYSTEM

The screen effects obtainable with the present-day 16mm. camera and projector possess, unfortunately, certain inherent limitations. The full beauty of an extended view or landscape, the concerted action in such sport events as racing, yachting regattas and athletic games—the vivid, pulsating life of street crowds or beach loiterers cannot be successfully presented on the screen with the standard 16mm. equipment. Even the 15 mm. wide angle lens contracting as it does the horizontal as well as the vertical field of view, will only focus the far flung beauties of a panoramic scene into a narrow, cramped range, often adding undesirable foreground and sky line to the picture.

To overcome these disabilities which were, until now, considered inherent in the presentation of motion pictures, Dr. Sidney Newcomer, a well-known physicist and mathematician, of New York, has evolved from an entirely new optical principle, the Staats-Newcomer-Goerz Cine-Panor.

This auxiliary lens system, consisting of a combination of cylindrical lenses, does not produce an image by itself, but has to be used in front of the regular photographic objective and the projection lens. It increases the horizontal field obtainable with cine lenses by 50 per cent without affecting the vertical dimensions of the picture. It is convertible from camera to projector. Films made with the Cine-Panor are projected through the same lens. It is manufactured by the C. P. Goerz American Optical Company, 317 E. 34th St., New York City.

With the Cine-Panor, the motion picture photographer is enabled to produce with his 16mm. camera and projector an artistic and truly panoramic screen picture.

▲

NEW RECORDING SYSTEM

The Electrotone Corporation, Gratiot Avenue at Racine Street, Detroit, Mich., announces a new recording system with a separate and distinct unit with no mechanical connection to the camera. The motor drive of the Electrotone recorder is entirely independent. As the speed of the camera is controlled and kept in synchronization by the recording unit, operating through the Eletrotone synchronizer, the recorder may be placed any reasonable distance from the camera and microphone. Electric wiring is the only connection between these units.

The compartments in the sound recorder house the complete optical system which includes the special electric lamp for the light, lenses and masks, the vibrating head controlling the reflector mirror, and the film housing with its mechanism.

Friction and vibration are practically eliminated.

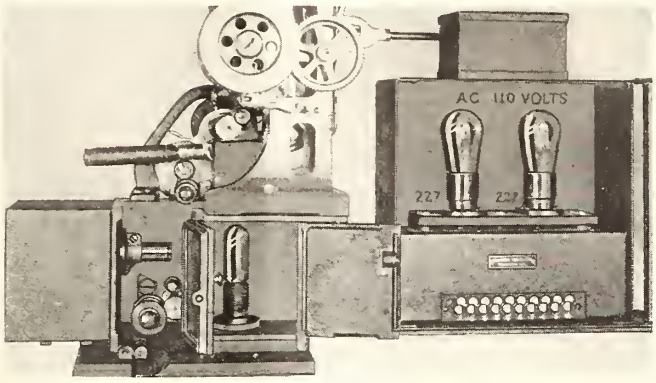
Any number of cameras may be used simultaneously. A constant source of light is used. Sound is recorded independently. The variable area type of recording is employed. Each revolving shaft is mounted on ball bearings. Base and housings are of aluminum. The drive sprocket is accurately machined and harmonically balanced and spring filtered through a flywheel.

▲

BEST DEVICES

A complete line of film rewind pulleys; spot lights and carbon savers are manufactured by the Best Devices Co. of Cleveland, Ohio. This company reports a growing business in this line of products.

FULL-SIZE EQUIPMENT AT JUNIOR PRICE



NEW A.C. MELLAPHONE

Where disc equipment is already in use, it is simply necessary to install the Mellaphone sound head and A.C. head amplifier. In this way, the present disc power amplifier, fader, and speaker may be used. Easily installed by any projectionist or electrician in a few hours. Write or wire for full information and Exhibitors Testimonial Booklet.

QUALITY in component parts, and detail of accuracy in construction are of primary importance to the projectionist. Quiet, smooth running and trouble-free. Uses no chains. Easily adjusted to utmost precision. Mellaphone equipment consistently delivers more than projectionists have expected.

Exhibitors are gratified by the clear full tones and unwavering excellent service Mellaphones are delivering. "Equal to the Best." Low prices have now enabled even the smallest exhibitors to make Mellaphone their choice. Two Mellaphone Sound Heads, All-Electric Amplifier, and Stage Speakers now complete an installation.

Write or wire for prices.

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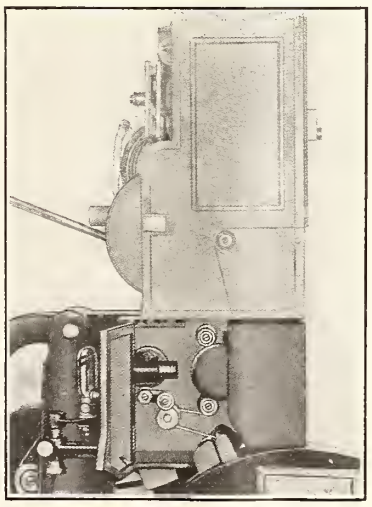
Now! SYNCROFLIM "B" SOUND HEADS FOR SIMPLEX OR POWERS

DESIGNED ESPECIALLY FOR SMALL THEATRES WHERE LOW PRICE EQUIPMENT IS DESIRABLE



Compact and sturdy in construction, simple to operate, perfect in efficiency. Smooth, quiet, positive drive assures even tone quality without distortion.

Sound heads for Simplex or Powers projectors are furnished complete and include optical systems, photo-cells, exciter lamps, adjustable motor mounting brackets, endless woven belts, grooved motor pulleys and all necessary attachments for projector.

EASY TO INSTALL — **$275 per pair complete** — **MONEY-BACK GUARANTEE**

Write for further information

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KEASBEY & MATTISON MARKETS SOUND SCREEN

A new sound screen marketed under the trade name of "Visibestone," consisting of a series of rod-like filaments, the shape and angles being based upon complicated mathematical formulae, has been introduced by the Keasbey & Mattison Co., asbestos manufacturers of Ambler, Pa.

While complete stereoscopic vision is not claimed for this new screen, the rod-like texture of the Visibestone screen is said to lend unusual depth to the projected picture, while the scientifically compounded mesh permits greater and more even sound filtration. It is also pointed out by the manufacturer that the new screen very definitely corrects distortion of both sight and sound. This correction is attributed to the special weaving and rod-like texture of the screen. Light is evenly reflected from the round surfaces of the asbestos threads into the remote angles of the auditorium.

Being basically fireproof, the liability of fire and consequent panic in the theater is greatly reduced, since there is nothing in the Visibestone screen to ignite or smoulder and give off poisonous fumes or noxious gases to alarm the audience, the company declares.

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CARBIDE AND CARBON VINYLITE RESIN USED IN NEW VITROLAC PHONOGRAPH RECORD

Union Carbide and Carbon Corporation through its subsidiary, Carbide and Carbon Chemicals Corporation, has entered into a contract to supply RCA-Victor large quantities of Vinylite resin to be used in molding the new Vitrolac records, which will play several times as long as the old type of record.

The unusual physical properties of Vinylite give many favorable features to the record, particularly toughness, flexibility, thinness. The absence of contraction or shrinkage when Vinylite is molded, it is stated, results in an unusually accurate reproduction of sound or music, including even the overtones of the high notes of a violin, with practically no surface noises. These characteristics have made it possible for RCA-Victor to design an entirely new type of record which will last three times as long as the old type record of the same diameter, and the surface of which contains twice as many sound producing grooves as the old type of record.

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RACON IMPROVEMENTS

Racon Electric Co., Inc., pioneer manufacturers of units, horns and sound equipment, announce improvements in their units, giving more powerful and more perfect response as well as increased efficiency. They also announce a reduction in prices on their complete line.

▲

A NEW FILM CLEANING DEVICE

In the near future, The Blue Seal Products Co., 260 Wyckoff St., Brooklyn, N. Y., will have ready for the market a newly designed film cleaning device for Simplex projectors. This device removes oil and dust from the film while it passes from one magazine to the other and also has an automatic valve which, in the event of fire taking place at the aperture, releases a specially prepared liquid instantly at the aperture.

This device has been on test in several of the largest metropolitan theatres for several months. It has met with unqualified approval from everyone who has operated it. (This news ties up with the story regarding the S.M.P.E. Projection Practice Committee's remarks on the subject of "protecting positive film," which will appear in the January issue of PROJECTION ENGINEERING.)

The liquid not only has cleaning properties but also acts as an emulsion preservative and prevents buckling as well as eliminating the possibility of new emulsion coating the tension shoes, a factor that caused many film fires in the past.

▲

NEW PORTABLE SOUND EQUIPMENT

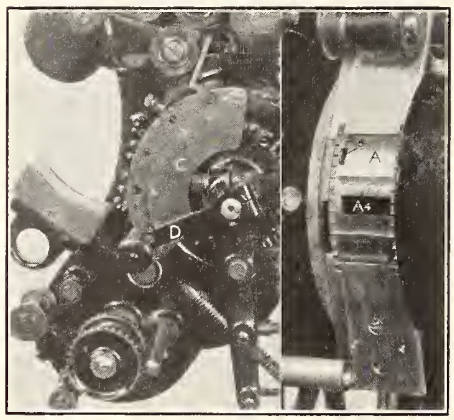
The Webster Company, 850 Blackhawk Street, Chicago, Ill., announces a new portable outfit for sound transmission.

The highlights of this portable are extreme compactness. The entire equipment, including speaker, phonograph and microphone, occupy a space slightly larger than one cubic foot. The tube arrangement is one 224 and two 247's, using a 280 for full-wave rectification; the weight being under forty pounds. Provision is made for mixing the output of the microphone and the phonograph together. Interconnecting cables are provided with polarized plugs to facilitate connection. The entire assembly is made in an attractive and substantial portable case.

▲

BELL & HOWELL FIVE-WAY SOUND PRINTING ATTACHMENT

The Bell & Howell Company is making an alternative sound printing attachment which can be fitted to their Model D continuous 35 mm. printer. Instead of having movable masks at the aperture, the five-way attachment utilizes a 220° drum in which are cut five openings. Four of the openings are arranged to take care of printing the sound and picture areas respectively of the negative, whether the negative is running forward or backward. The fifth opening is arranged to print ordinary "silent" negatives. In other words, instead of arranging masks to give the various combinations of aperture openings, the five-way wheel is turned to the correct openings. These openings are indexed to facilitate the operator using them for sound and picture area printing, in correct sequence.



Five apertures cut in a 220° drum and indexed to facilitate operation by registering correct aperture for sound or picture printing. (A) The drum, in which are cut five openings—one full aperture, one each for sound and picture printing for operating the negative forward or reverse (A3) Sound aperture—reverse run; (A4) Picture aperture—forward run; (A5) Sound aperture—forward run; (C-1-2-3-4-5) Index dial; (D) Lever and pin which move drum to opening indicated on Index dial.

▲

ELECTRODYNAMIC UNIT

An electrodynamic speaker has been brought out by the Fox Engineering Company of Toledo, O., for use in theatre sound and public-address systems.

A particularly interesting feature of this unit is an interchangeable "voice coil cartridge," which may be removed for the purpose of substituting a new one (instead of purchasing an entirely new unit) by merely removing one "master" screw.

The outer bowl is stamped from one piece of heavy alloy. In this bowl rests the "field coil" for supplying the magnetic energy. This energy, which is of six volts, can be supplied by either an ordinary 6-volt storage battery, or a specially designed dry rectifier also made by the Fox concern.

▲

ALUMINUM HORN OFFERS NEW ADVANTAGES

The first size in a full series of all-metal trumpet horns has just been offered the sound projection trade by the Fox Engineering Company, Toledo, manufacturers of horns and high-powered electro-dynamic units.

While the tone characteristics and physical requirements of the perfect amplifying horn have long been recognized by sound engineers, the actual attainment of these characteristics has been a matter of slow and painstaking development. All-metal horns are not new, but an all-metal horn that is entirely free from rasping and vibration noises is an achievement that will be welcomed by every sound engineer in the country.

This new Fox horn, of conventional trumpet design, has consistently shown, under all conditions, a clear, bell-like tone that has surprised and pleased every engineer that has tested it.

Notwithstanding the fact that these horns are 6 ft. long, and have a bell diameter of 32 inches, they are of spun aluminum and free from lateral joints or seams. This construction makes possible a definite radial uniformity that accoutns for its fine tone. Aluminum is not only an ideal medium from the standpoint of resonance. It is easy to set up and take down for temporary use, and when knocked-down into its two integral parts, is extremely easy to store and ship.

These horns are entirely free from the influence of atmospheric and moisture conditions and are almost indestructible in normal use. Weight is only 12 pounds.

▲

NEW S. O. S. SOUND-ON-FILM AMPLIFIER

After many months of experiments, S. O. S. engineers have developed a sound-on-film amplifier which totally eliminates all batteries, chargers, rectifiers motor-generators, and complicated wiring. Proper unified amplification has been a problem with many theatres wishing to install sound-on-film reproduction, but with the advent of the new S. O. S. unit, the most pleasing results are now possible with a minimum of expense and an extremely simple installation.

Among the outstanding features of the S. O. S. unit are all a-c. electric operation, photocell balancers, volume fader control, changeover switch, jewelled indicators, direct current meter, master a-c. switch, real high-frequencies, junction box outlets, no messy batteries, 4-stage amplification, built-in P. E. C. amplifier supplies exciter current, non-sync input jack, shielded photocell leads, exciter lamp ammeter, easily accessible, simple to service, matched impedance for any sound head or speaker.

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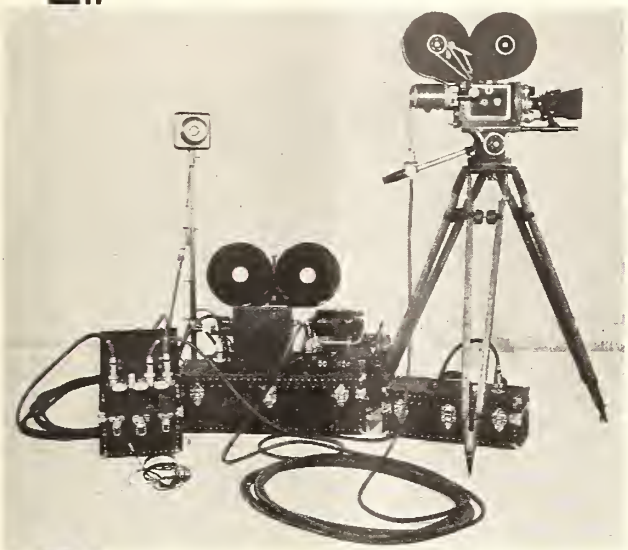

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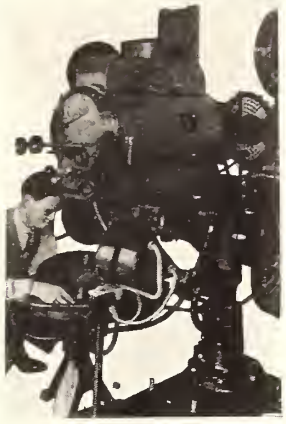

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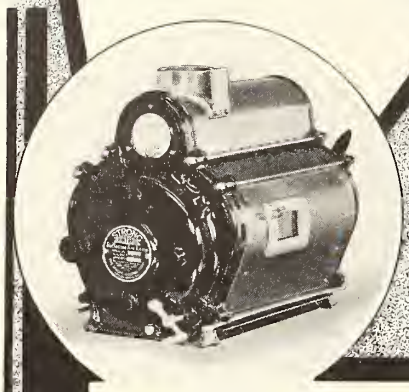

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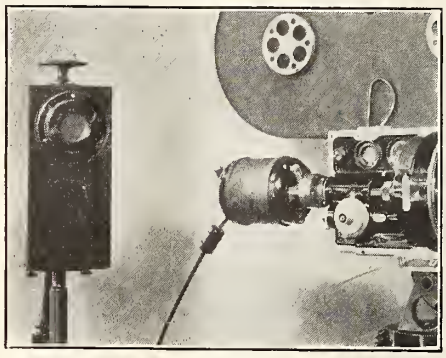

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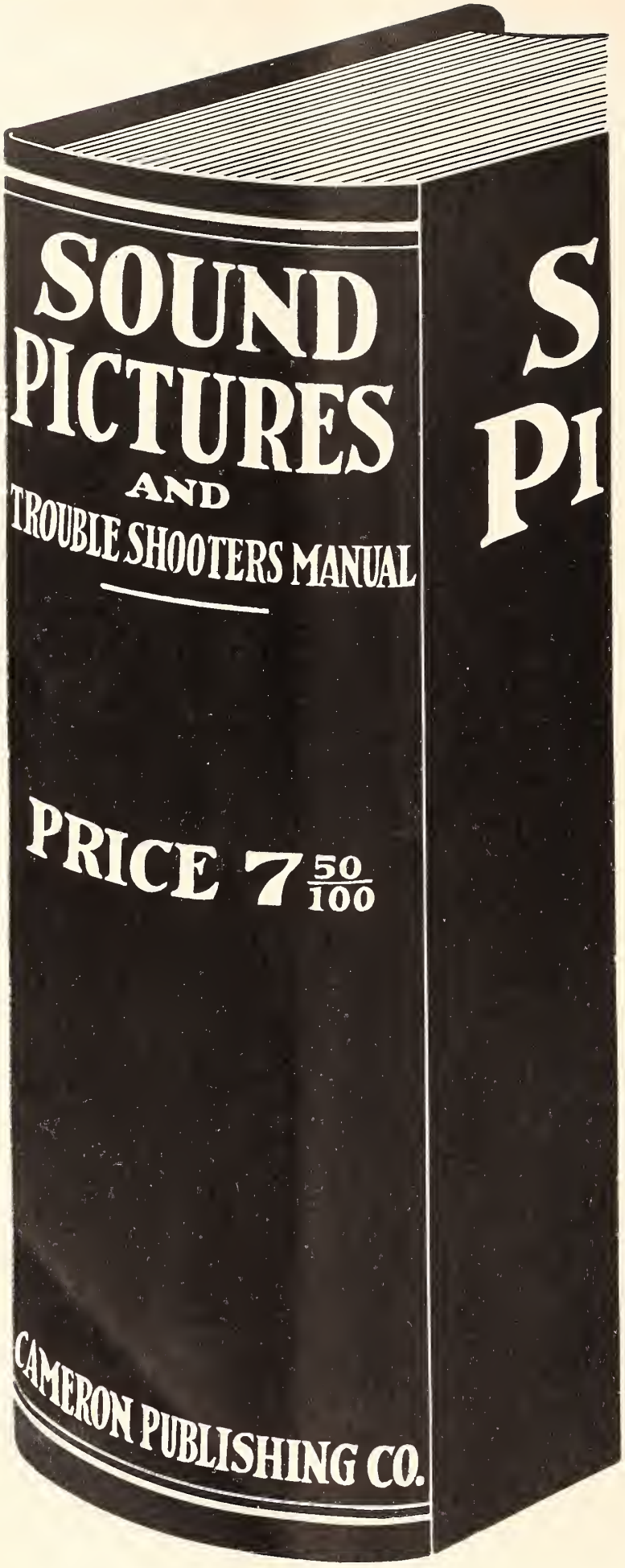

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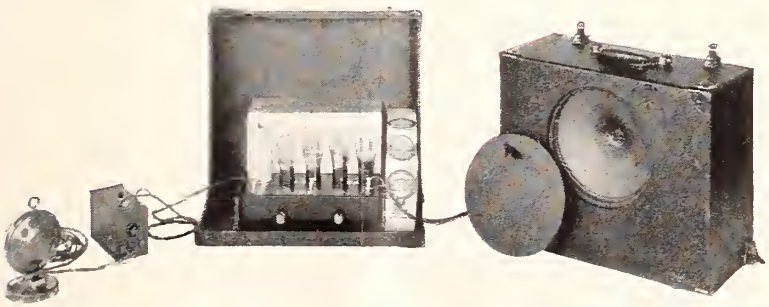

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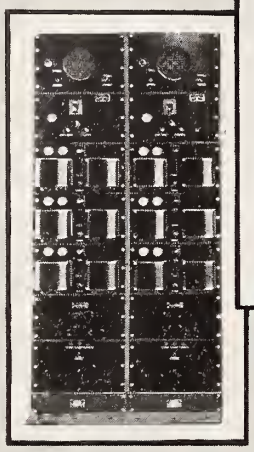

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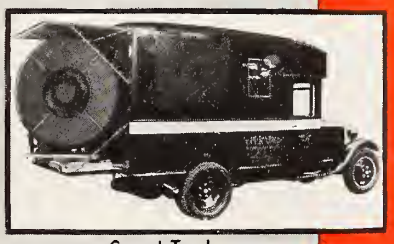

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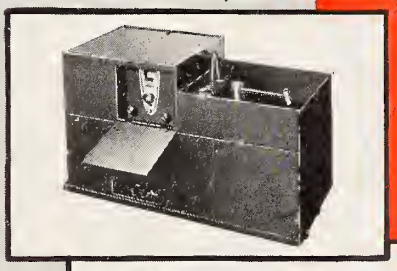
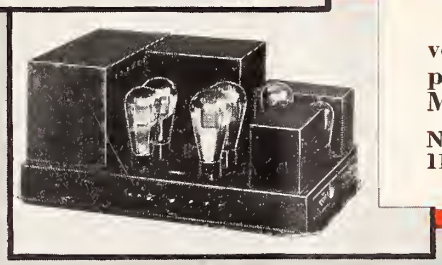
Portable Address System





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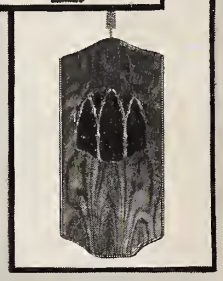

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